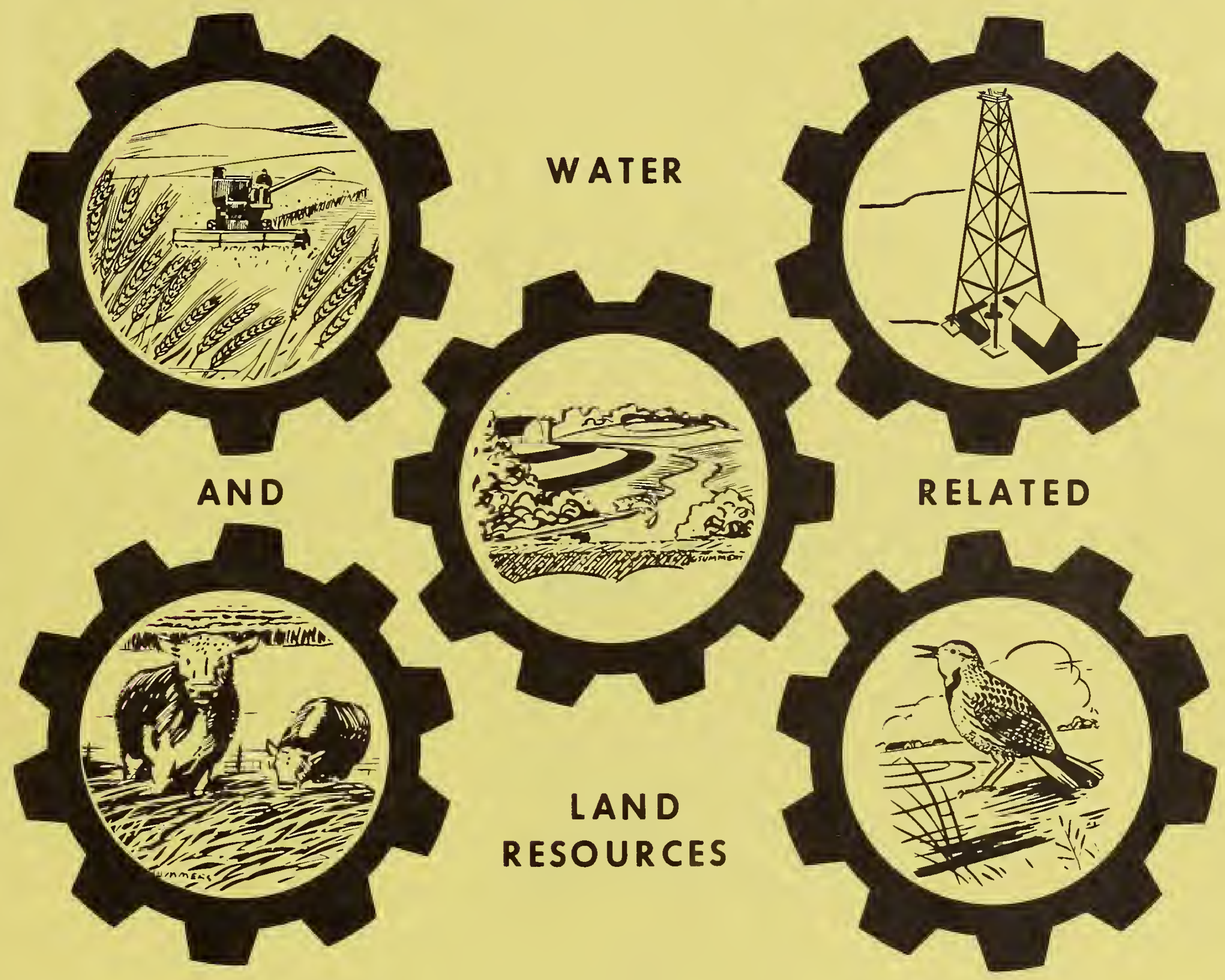
ARKANSAS RIVER BASIN
KANSAS



U. S. DEPARTMENT OF AGRICULTURE
REPORT

PREPARED BY

SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE
STATE OF KANSAS

DECEMBER 1974

RIVER BASIN STUDY REPORT

WATER AND RELATED LAND RESOURCES

ARKANSAS RIVER BASIN

KANSAS

Prepared under the Authority of
Section 6 of Public Law 566, 83rd
Congress, 68 Stat. 666, as amended

Prepared by

Soil Conservation Service

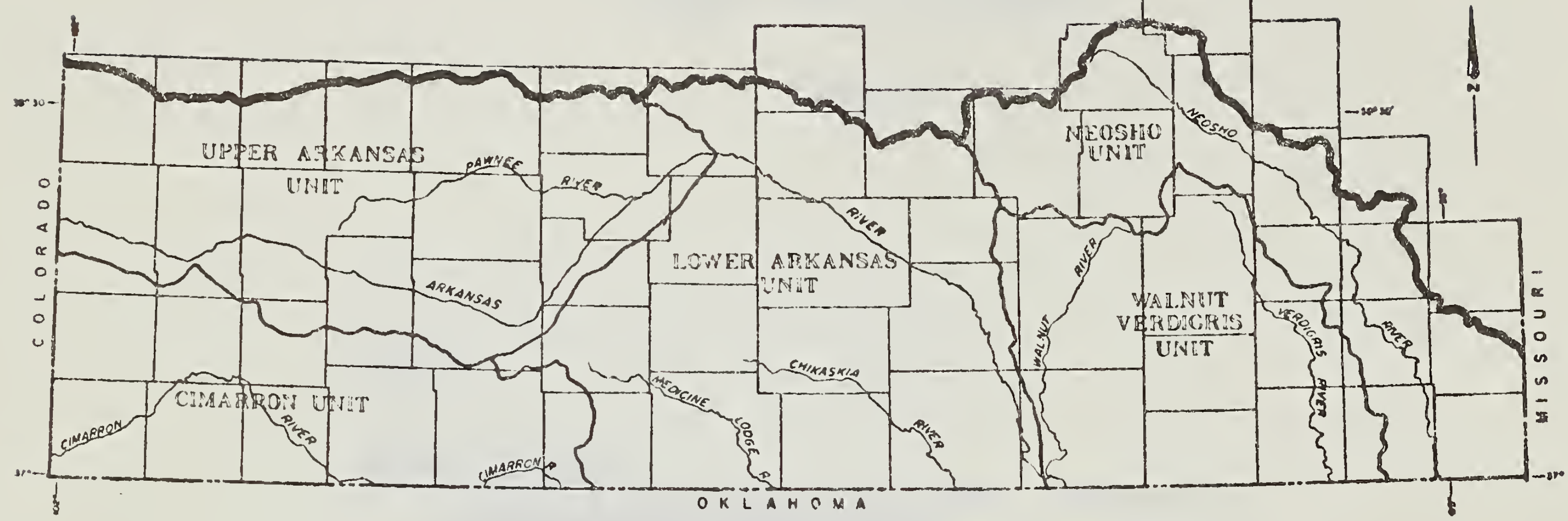
Economic Research Service

Forest Service

State of Kansas

December 1974

STUDY AREA


UPPER ARKANSAS UNIT
LOWER ARKANSAS UNIT
NEOSHO UNIT
WALNUT VERDIGRIS UNIT
CIMARRON UNIT
PAWNEE RIVER
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CHIKASKIA RIVER
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CIMARRON R
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OKLAHOMA

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ARKANSAS RIVER BASIN IN KANSAS

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SUMMARY

Objective and Scope of Study

The general purpose of this Type 4 cooperative river basin survey report is to provide basic information needed by the U.S. Department of Agriculture and the State of Kansas for a coordinated program for water and related land resource development in the Kansas portion of the Arkansas River Basin. Problems concerning the conservation and use of land and water are identified and recommendations are made for solving these problems through programs of the Department and other federal and state agencies.

There is emphasis on opportunities for project development through initiative of local sponsors. Projects under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566) and the Resource Conservation and Development Program are primary examples. Other opportunities exist for individual and group developments.

Purposes considered eligible for technical and financial assistance are land use and treatment, flood prevention, agricultural water management, municipal and industrial water supply, water quality management, recreation, and fish and wildlife.

It is recognized that social, institutional, legislative, and economic considerations may impede some recommended developments and increase the interest in others. These factors may establish the need for studies beyond the scope of this survey.

The total potential development program recognized in this report as being needed to meet total demand by the year 2020 has been carefully examined to extract the Early Action Program needed within the next 10-15 years. This program is presented in the "Opportunities for Development with USDA Programs" section for each planning unit.

The study was carried out on a reconnaissance level with data from previous investigations and surveys used wherever possible.

Description of the Basin

The study area is the Arkansas River Basin in Kansas. It is about 41,865 square miles in size and covers approximately the southern half of Kansas.

The study area was divided into five planning units, as designated by the State. Their names and sizes are:

Name	Size	
	Square Miles	Acres
Upper Arkansas Unit	10,323	6,606,600
Cimarron Unit	6,788	4,344,300
Lower Arkansas Unit	11,600	7,424,100
Walnut-Verdigris Unit	6,839	4,377,300
Neosho Unit	6,315	4,041,400
Total	41,865	26,793,700

Climate of the study area varies from semi-arid continental in the west to humid continental in the eastern portion. Average yearly precipitation ranges from 16.0 inches to 42.0 inches west to east across the basin. Normally, three-fourths of the annual precipitation occurs during the six month growing season, April through September. Temperature variations are typical of mid-latitude, continental locations. Mean January temperatures are in the 30-34 degree range. Mean July temperatures across the basin are fairly uniform at about 80 degrees.

The primary land use1/ of the basin is:

Cropland	15,251,600 acres
Rangeland	9,273,400
Forest	555,100
Other	1,713,600
Total	26,793,700 acres

Nearly 73 percent of the land in the basin is in Capability Class I, II, III, or IV. The irrigated acreage is estimated to be 1,340,000 acres as of 1971.

1/ Summarized from the 1967 USDA Conservation Needs Inventory

CAPABILITY CLASS I CROPLAND ON BOTTOMLAND IN CHASE COUNTY.

BORDER IRRIGATION IN NORTHEAST HASKELL COUNTY.

Population in the study area increased from 885,600 in 1940, to 1,059,300 in 1960, and is projected to be 1,316,900 in 1980, 1,662,300 in 2000, and 2,072,400 in the year 2020. The major shift in population has been from rural farm to urban. Rural farm population decreased from 283,100 in 1940 to 150,300 in 1960 and urban population increased from 385,200 to 658,300 during the same period. Population trends have been dominated by the growth of the Wichita metropolitan area in Sedgwick County.

Total employment in the study area increased from 284,400 in 1940 to 393,400 in 1960 and was projected to be 511,000 in 1980, 655,000 in 2000, and 829,000 in 2020. Agricultural employment decreased between 1940 and 1960 and is projected to decrease even more in the future. The major increase in employment is projected to be in the trade and service sectors.

Per capita income in the study area was $1,753 in 1959 compared to $1,850 for the U.S. Median family income was also slightly below that for the U.S. There is a large variation in income among the sub-areas.

The economy of the area is predominantly based on agricultural production with the exception of the Wichita-Newton-Hutchinson industrial area. Total cash receipts from farm marketing were $617 million in 1964 an increase of 59 percent since 1949. Livestock sales accounted for 62 percent of the total receipts as an increasing amount of crop production is fed to livestock.

According to the 1964 U.S. Census of Agriculture, approximately 95 percent of the total study area is in farms. Of the land in farms, 60 percent is cropland. About 55 percent of the cropland harvested is in wheat and 23 percent in grain sorghum. Some 803,000 acres of cropland were irrigated in 1964. This was a sixfold increase since 1949. Some 1,340,000 acres are presently (1971) estimated to be irrigated. It is anticipated the irrigated acreage will continue to increase in the future.

One of the major changes occurring in the structure of agriculture in the study area is the increase in size of farms. The average size of farm increased from 414 acres to

606 acres between 1949 and 1964. During this same period the number of farms decreased 28 percent.

The annual current normal value of crop and pasture production is estimated to be 440 million dollars. This is expected to increase by 55 percent by 1980 even if only the present level of irrigation is maintained. With projected irrigation development the current value is expected to increase by 58 percent. It is estimated that the basin has the potential for producing 80 percent more in 1980 than the current normal production.

Problems and Needs

The principal water and related land resource problems and needs are presented in three general categories:

1. Watershed Protection and Management
2. Floodwater and Sediment Damages
3. Water Management (agricultural and non-agricultural)

These problems and needs can be solved through interest and activities of local people using their own resources as well as state and federal assistance. This report will assist local people in decision making processes and will guide those providing technical and financial assistance. The report provides a factual appraisal of land and water resource problems, needs, and opportunities for solution.

Watershed Protection and Management - Soil erosion and the resulting sedimentation is one of the most serious problems. Most of the severe erosion occurs on steeply sloping cropland with shallow to moderately deep soil without conservation treatment. Pastures in poor to fair condition are losing soil by sheet erosion at an accelerated rate accompanied by some gully erosion. The following summary of cropland and rangeland conservation treatment applied and remaining to be applied will help to assess the extent of the watershed protection and management needs:

Cropland Treatment	Acres	
Treatment Adequate		4,809,400
Remaining to be Applied		
Residue Management	3,283,800	
Contour Farming	414,300	
Stripcropping, Terraces, Diversions	5,614,700	
Permanent Cover	203,500	
Drainage	235,200	
Irrigation Systems	567,900	
Irrigation Water Management	122,800	
Subtotal Remaining to be Applied		10,442,200
Total Cropland		15,251,600

Rangeland Treatment	Acres	
Treatment Adequate		4,029,300
Treatment Not Feasible		27,900
Remaining to be Applied		
Proper Grazing Use	3,204,100	
Deferred Grazing	134,600	
Brush Control	1,068,500	
Range Seeding	809,000	
Subtotal Remaining to be Applied		5,216,200
Total Rangeland		9,273,400

Forest Management - The future of timber supplies is in the hands of private-woodland owners, who own practically all of the forest resource. In general, the woodlands are in poor condition and are producing far below their potential.

Fire has been of considerable significance as a causative agent of range and woodland damage and deterioration. Debris burning continues as the largest single cause of uncontrolled fires with about one-fourth of the fires resulting from this activity. Statistics kept by organized rural fire districts showed that for the period 1963-1967, on the average, in their areas in the basin 760 fires burn 74,000 acres per year.

Forestland treatment needs are:

Forestland Treatment	Acres
Forest surveys, management plans, and technical assistance	453,900
Thinning, pruning, and release cutting	229,600
Tree planting or seeding	205,200
Insect and disease control	65,500
Accelerated fire control	309,200
Forest watershed protection and hydrologic treatment	660,000

Floodwater and Sediment Damages - Average annual flood damages on tributary streams total $15,667,300 within the basin. The USDA was requested to evaluate floodwater and sediment damages on tributary streams only in this cooperative study. The total tributary floodplain area was determined to be some 1,245,220 acres. Floodplains along major streams such as the Arkansas, Walnut, Verdigris, Neosho, Cottonwood, and Spring Rivers are being studied by the U.S. Army Corps of Engineers and are not included in this study. Major damage categories and amounts based on 1980 projections are:

Crop and Pasture	$9,937,100	
Other Agricultural	1,438,800	
Land	883,000	
Total Agricultural		$12,258,900
Road and Bridge	$1,700,600	
Railroad	84,400	
Urban	115,900	
Other	35,800	
Total Non-agricultural		$ 1,936,700
Indirect		$ 1,471,700
Total Average Annual Damages		$15,667,300

Water Management (Agricultural) - Drainage problems affect only a minor portion of the basin. Some 235,000 acres of cropland have excessive water problems which require drainage, generally of a project nature. The most concentrated problem area is found in the Lower Arkansas Unit where 151,000 acres of cropland have impaired drainage or a naturally high water table. The need for a project approach to a solution in this area will require additional study.

The irrigated acreage in the basin is estimated to be 1,340,000 acres. There is much potential for continued growth of irrigation, especially in the Lower Arkansas Unit where underground water and suitable land are abundant. The annual water demand for irrigation exceeds recharge causing groundwater depletion in the Upper Arkansas and Cimarron Units. Groundwater supplies in some parts of the basin will become inadequate to support irrigation within the next 50 years. Measures that will help to conserve the groundwater reservoir are needed. These include irrigation water management, moisture conserving land treatment practices, and structural measures for groundwater recharge.

Groundwater supplies are generally inadequate for rural domestic and livestock needs in a large part of the eastern portion of the basin. Existing surface supplies available for such purposes have not been reliable during droughts. There is a need for more rural water districts to supply rural domestic and livestock water. Surface supply may be the only practical water source for many of these districts. Maximum economy and reliability can be obtained if many users are tied to a single large reservoir. Multi-county planning such as that available through the Small Watershed Program or the Resource Conservation and Development Program is a useful tool in matching efficient supplies with areas of need.

Water Management (Non-agricultural) - There will be a need for more reservoir storage to meet future municipal and industrial demands in parts of the Neosho and Walnut-Verdigris Units. Groundwater supplies are generally inadequate in these areas.

The western half of the basin is generally short of water storage for pleasure boating, fishing, and swimming. Other recreation activities such as picnicking and sightseeing would also benefit from water storage developments in this area. Access is a major factor limiting the amount of stream fishing throughout the basin.

According to the Kansas Water Resources Board, fifty percent of the mean annual flow will provide more than enough water for municipal and manufacturing pollution abatement needs throughout the basin were it to be developed. Beyond 1990 more strict treatment requirements or additional surface water flows will be needed in western portions of the basin. The fisheries resource is severely affected by various forms of pollution (municipal, industrial, feedlot runoff, and mining operations) along localized stream reaches in the Neosho Unit. Animal feedlot wastes are currently a widespread pollution problem but the Kansas State Department of Health expects essentially complete control within five to ten years through existing programs. Sediment is the largest single source of stream and reservoir pollution. Sediment production will be reduced only as fast as land treatment is applied.

Floodplain phreatophytes, cottonwood (Populus sargentii), salt cedar (Tamarix ramosissima), and willow (Salix spp.) present a dual problem; through transpiration they waste

large quantities of water, and by choking river channels they create a flood hazard. This problem occurs mainly along the Arkansas River above Great Bend. This vegetation does, however, provide desirable habitat for big game and other wildlife.

Findings and Conclusions

Land treatment has been applied on approximately 4,809,400 acres of cropland and 4,029,300 acres of rangeland. This represents about 36 percent of the total needs. Land treatment is needed on an additional 10,442,200 acres of cropland and 5,216,200 acres of rangeland in order to conserve these valuable resources and protect the environment from sediment and other agricultural pollutants. The total cost of installing the remaining land treatment needs is estimated to be $290,700,000.

There are about 15,251,600 acres of cropland in the basin. Approximately 490,000 acres of this total are in Land Capability Classes V-VIII most of which should be retired from crop production. Forty-six percent (4,230,000 acres) of the 9,273,400 acres of rangeland is in Classes I-IV. Only part of the Classes I-IV rangeland could be used for cropland due to the size of suitable soil area and the association with non-arable soils. This points out the potential that exists for increased cropland area. However, projections for the year 2020 show that about one percent less cropland will be required than at present.

Western portions of the basin have underground water supplies and land suitable for irrigation in amounts large enough to support additional irrigation development. Eastern portions, although lacking in groundwater, have surface water yields which, if developed, are adequate to support supplemental irrigation. The current basin irrigated acreage is about 1,340,000 acres. The projected irrigated acreage for the year 2020 is 4,083,800 acres. The projected annual irrigation water demand for the year 2020 is 9.9 million acre feet, mostly to be met by groundwater reserves. By this time frame two-thirds of the present groundwater reserve will be depleted, assuming no significant advances in groundwater recharge techniques.

There are about 555,100 acres of forest land in the basin. Approximately 454,400 acres or 82 percent of this is commercial forest area. The forest lands have good potential for contributing to economic development and diversity of the basin. The forests enhance the environmental quality of the basin in many ways. Chief contributions are in the area of sediment and erosion reduction, water quality, air quality, scenic

beauty and aesthetics, landscape diversity, modification of climatic extremes including wind, and wildlife habitat.

Forest management has not been practiced on any extensive areas. Harvesting practices in the past consisted primarily of removing large, high value trees leaving a residual stand of low quality trees mostly of less desirable species. Management needs include reforestation, stand improvement, harvest cutting, grazing reduction, and forest pest control. Current forest management efforts are inadequate, primarily because of a lack of funds. An intensive program of forest land treatment is needed to conserve and enhance the economic and environmental values of the forest. The total cost of the needed forest land treatment is estimated to be $20,756,100.

The National Forest Development and Multiple Use Program have extensive work planned for the next 10-15 years on the Cimarron National Grassland. The Forest Service is cooperating with the Kansas State Extension Forester on similar programs in state and private woodlands.

Proper management of the National Grassland and other grazing lands throughout the basin is one of the most important factors in maintaining a high quality environment. Shelterbelts and farmstead windbreak plantings have improved and modified the environment. They have been especially important in protecting the soil from wind erosion, in controlling snow drifting and spreading, protecting crops, shielding livestock from winter storms, muffling noise from highways, and reducing fuel requirements for heating homes. Special tree and shrubbery plantings are being made to enhance the beauty and safety of highways; to create pleasant attractive parks, picnic and camping sites, and to provide food and shelter for wildlife.

The basin was divided into 225 watersheds covering 41,865 square miles. Portions of some of these watersheds lie in adjoining states. A total of 3,480 reservoir sites in these watersheds were examined during this study. The total drainage area of sites studied is nearly 16,000 square miles or 38 percent of the basin. Floodwater retarding structure sites are available where needed for reduction of flood flows in most of the basin. Multiple-purpose sites are primarily limited to eastern portions of the basin where surface water yield is greater. About 450 reservoir sites were recognized as having multiple-purpose development potential with a total physical storage capability of 377,000 acre feet. This volume is above sediment and floodwater storage reserves that would be necessary for single purpose development.

The upstream watershed program has proven popular in all parts of the basin as evidenced by the following statistical summary for projects completed, authorized for construction, or authorized for planning (potential reservoir capacities are also shown):

Watershed Project Status*	No. of Projects	Total Area Covered (sq.mi.)	Potential Reservoir Storage Capacities: Sediment Pool (ac.ft.)	Floodwater Detention (ac.ft.)	Other 1/ (ac.ft.)	Total (ac.ft.)
Completed	6	327.36	6,274	36,109	660	43,043
Authorized for Construction	13	2,256.10	48,661	233,698	34,016	316,375
Authorized for Planning	14	3,143.15	30,132	192,725	3,175	226,032
Total	33	5,726.61	85,067	462,532	37,851	585,450

1/ Other purposes include water storage for recreational, municipal-industrial, and agricultural use.

WATERSHED RESERVOIR IN BEE CREEK WATERSHED, MONTGOMERY COUNTY.

* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

Following is a comparison of project costs and benefits for the upstream watershed program:

Watershed Project Status*	No. of Projects	Total Structural Measure Cost (dollars)	Average Annual Cost (dollars)	Average Annual Benefits (dollars)
Completed	6	4,426,100	185,100	396,800
Authorized for Construction	13	35,252,800	1,366,800	2,575,900
Authorized for Planning	14	23,894,000	1,275,100	1,798,400
Total	33	63,572,900	2,827,000	4,771,100

Future watershed project development evaluated in this report includes: (1) early action projects (installation needed within next 10-15 years) - those projects which are physically and economically feasible and socially acceptable and are needed to solve urgent problems; (2) long range projects (may be installed by 2020) - those projects which are physically feasible and for which a need is recognized but are not economically feasible at this time; (3) total development potential recognizes a physical solution for all problems even though economic feasibility may not be apparent through the year 2020.

Forty-five upstream watersheds were found to be feasible for early action project development. (Exhibit 38) These are in addition to 14 feasible projects which have been authorized for P.L.566 planning but which have not yet been authorized for installation. The 45 early action projects include an area of nearly 10,000 square miles or 24 percent of the total basin area.

Some 293 reservoir sites, controlling about 3,900 square miles, could be developed in the 45 early action projects. Approximately 40 of the sites could be developed

* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

for multiple purposes. Some sites were suitable only for flood control and recreation development, but others were considered likely for flood control, recreation, fish and wildlife, agricultural and municipal-industrial water development. Storage volumes will include: 139,800 acre feet for sediment; 608,000 acre feet for floodwater; and 27,500 acre feet for other uses. A total of 56 miles of channel work in four of the projects was necessary to supplement the level of flood protection provided by floodwater retarding structures. Twenty-eight miles of this total is new channel construction across cropland needed to provide adequate outlets for structure release flows.

The forty-five early action projects would have a total structural measure installation cost of $67 million. Amortized at 5 1/8 percent interest over a 100-year period, the average annual structural measure cost would be about $3,829,600.

Average annual structural measure benefits for the 45 early action projects total $5,153,700. Land treatment in these projects would produce $364,300 of additional annual flood damage reduction benefits.* Installation of all 45 early action projects would result in a return of $1.35 for each $1.00 invested. More than 450,000 acres of floodplain land would be protected by these projects. Some 6,200 surface acres of recreation water would be provided. Water supplies would be made available to ten rural water districts and three cities.

Thirty-seven additional watershed projects covering a total of 5,187 square miles fall into the long range category. These projects show benefit-cost ratios close to but below unity based upon current evaluation procedures and the amortization rate for 5 1/8 percent interest (100-year period). These projects should be re-evaluated if any favorable changes occur in evaluation factors. Total annual benefit and cost figures for these projects are:

Benefits	$1,832,700
Costs	$2,026,800

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* The other benefits to land treatment such as the value of erosion reduction and increased production were not evaluated. Land treatment costs in the 45 early action projects were not computed separately from the cost of applying the total basin land treatment needs.

The Resource Conservation and Development Program has demonstrated its value in the basin. RC&D projects are providing a multi-county planning tool that opens new avenues of cooperation. Many of the project measures will aid in water and related land resource development. Continued emphasis in this program is recommended. RC&D projects, their status (12/31/74), number of counties, and basin area involved are:

RC&D Project Name	Project Status	No. of Counties in the Basin	Basin Area Covered (acres)
Sunflower	Authorized for Installation	7	3,998,720
See-Kan	Authorized for Installation	9 1/	2,859,884
Flint Hills	Authorized for Installation	4 1/	1,858,302
Lake Region	Authorized for Planning	2 2/	406,152
Total			9,123,058

1/ Parts of three counties lie outside the basin
2/ Four other counties lie outside the basin

Rural water districts cover a large part of the eastern portion of the basin. This program will continue to spread because of remaining groundwater quantity and quality problems. More efficient water supplies are needed in the future. Larger rural water districts or several districts utilizing a large reservoir may prove necessary to provide dependable, economical supply. Opportunities for agricultural water development in upstream watersheds should be more widely used.

Status

Statistical summaries and other report information for the P.L. 566 watershed program was compiled using project status as of August 1, 1970. Changes in status that occurred between August 1, 1970, and December 31, 1974, are shown below. Exhibits 34 and 38 have been revised to reflect December 31, 1974 status.

Watershed	Planning Unit	Status 12-31-74
Fall River	Walnut-Verdigris	Completed
Little Walnut-Hickory	" "	"
Spring Creek	Lower Arkansas	"
Twin Caney	Walnut-Verdigris	"
Hargis Creek	Lower Arkansas	"
West Sector Whitewater River	Walnut-Verdigris	Authorized for Construction
East Sector Whitewater River	" "	"
South Sector Upper Walnut River	" "	"
North Sector Upper Walnut River	" "	"
Big Creek	Neosho	"
Diamond Creek	"	Authorized for Planning
Middle Creek	"	"
Peyton Creek	"	"
South Fork, Cottonwood	"	"
Rock Creek	"	Application Received
Otter Creek	Walnut-Verdigris	"
James Draw	Upper Arkansas	"
Allen Creek	Neosho	"
Doyle Creek	"	"
Grouse-Silver Creek	Walnut-Verdigris	"

ADDENDUM

Arkansas River Basin in Kansas

Final Draft

This addendum shows the effect of various interest rates on Early Action Projects.

	Interest Rate		
	5 1/8	5 5/8	6 7/8
UPPER ARKANSAS UNIT			
Number Early Action Projects	17	17	2
Average Annual Benefits	1,333,900	1,333,900	345,600
Average Annual Costs	1,034,300	1,126,500	209,700
Benefit:Cost Ratio	1.3:1	1.2:1	1.6:1
LOWER ARKANSAS UNIT			
Number Early Action Projects	5	4	1
Average Annual Benefits	679,900	568,100	146,200
Average Annual Costs	573,500	503,800	135,500
Benefit:Cost Ratio	1.2:1	1.1:1	1.1:1
CIMARRON UNIT			
Number Early Action Projects	0	0	0
WALNUT-VERDIGRIS UNIT			
Number Early Action Projects	2	2	0
Average Annual Benefits	142,100	142,100	0
Average Annual Costs	121,900	132,700	0
Benefit:Cost Ratio	1.2:1	1.1:1	0
NEOSHO UNIT			
Number Early Action Projects	21	21	18
Average Annual Benefits	2,997,800	2,997,800	2,637,800
Average Annual Costs	2,099,900	2,279,400	2,332,000
Benefit:Cost Ratio	1.4:1	1.3:1	1.1:1
TOTAL			
Number Early Action Projects	45	44	24
Average Annual Benefits	5,153,700	5,041,900	3,489,600
Average Annual Costs	3,829,600	4,042,400	2,709,200
Benefit:Cost Ratio	1.3:1	1.2:1	1.3:1

INTRODUCTION

INTRODUCTION

In 1963 the Kansas Legislature enacted the "State Water Plan Act," which in conjunction with the "State Water Plan" passed in 1965, constitutes a major policy statement by the State of Kansas in regard to the development of a State Water Plan and state financial participation in water resources projects and programs for flood control and conservation purposes.

The State Water Plan requires the Kansas Water Resources Board to formulate and adopt long-range goals and objectives for (1) flood control and conservation, and (2) the development, utilization, and disposal of water based on (a) careful consideration and estimation of the water resources of the state and (b) the present and projected water use and control needs of the people of Kansas. The plan shall include the location, character, and extent of existing and proposed projects, programs, and facilities to accomplish the goals and objectives. Further, the plan shall specify standards for operation and management of such projects, programs, and facilities. The plan is the basis for coordinated, balanced, and harmonious development of the water resources of the state.

The State Water Plan Act provides for state financial participation in water development projects. Any public corporation shall be eligible for state financial assistance covering a part of the costs of lands, easements, and rights-of-way necessary for the development of water resources projects if such projects provide benefits beyond the boundary of the public corporation. The Board may also recommend the inclusion of conservation storage features for water supply purposes in any proposed water development project of any public corporation. Such storage may be provided at state expense if, in the opinion of the Board, the water will be needed within the state in the future. For the purpose of providing the Legislature with information as to the probable future program costs on a continuing basis, the Act stipulates that the Board shall annually project estimated future costs of water management projects for a twenty-five year period.

The Kansas Water Resources Board is making a water resource study of the State in the interest of water control, water flow, water supply, agricultural, municipal, industrial, and recreational water use, stream pollution, sedimentation,

additional basic data, and for other purposes. The study involves developing hydrologic unit reports for water resource development in accordance with provisions of the State Water Plan. For the purposes of this study the State has been divided into twelve planning units.

The Board requested the U. S. Department of Agriculture to cooperate and undertake with it a study of the Kansas portion of the Arkansas River Basin comprising five of the twelve planning unit areas (refer to letter to the Administrator, SCS, from the Executive Secretary of the Kansas Water Resources Board dated July 10, 1963). The five planning units include: Upper Arkansas, Cimarron, Lower Arkansas, Walnut-Verdigris, and Neosho. Total area involved is 41,865 square miles or approximately the southern half of Kansas. The Department of Agriculture agreed to cooperate in the study to provide information needed by the Department and the State of Kansas for development of a coordinated program for water and related land resource development. It was also agreed that information should be presented in the survey report on a planning unit basis in so far as possible. The study will provide the Kansas Water Resources Board information for use in its water resources planning activities. It will also provide the Department information for use in connection with the development of work plans under the Watershed Protection and Flood Prevention Act (P.L. 83-566). It is expected that the data obtained in this survey will also fulfill in part the needs of a future framework study of the Arkansas-White-Red Region.

Major objectives of the study included:

I. Projection of economic development as a basis to assess needs for development of water and related land resources.

II. Inventory agricultural and rural community water and land resources availability and needs for resource development.

III. Analysis of potential water and related land resource development.

IV. Identify projects needed within the next 10 to 15 years ("Early Action") within an overall plan of

water and related land resource development to satisfy upstream agricultural and rural needs.

Authority to participate in the study was provided the Department of Agriculture by Section 6, Public Law 83-566, as amended. Surveys and investigations were carried out in accordance with a Memorandum of Understanding dated April 15, 1968, between the Economic Research Service, Forest Service, and Soil Conservation Service. General direction was provided by a USDA Field Advisory Committee which included representatives from the three agencies.

The Kansas Water Resources Board cooperated with the United States Department of Agriculture in carrying out this study. The federal and state representatives considered the objectives of this survey and consulted from time to time on procedures and methodology. Representatives discussed procedures, progress, and results with other state and federal agencies as deemed appropriate during the course of study and at completion of the final report.

Procedures for analysis of tributary floodplain damages and small watershed program effect utilized readily available data to the extent possible. Much of the information needed for the inventory of the present situation and for analysis of the effects of future development were derived from existing watershed planning data. In portions of the basin where there was little watershed planning activity, detailed studies were made on sample watersheds.

Existing USGS topographic quadrangle maps, county highway maps, reconnaissance and detailed soil surveys, and aerial photographs and mosaics were utilized to (a) determine tributary floodplain acreage and to (b) inventory potential storage sites and develop capacity and cost data for these sites. The 1967 USDA Conservation Needs Inventory provided land use and treatment data. Crop damage and other agricultural damage rates per acre were estimated by a procedure utilizing factors of gross floodplain value, flood frequency, relative floodplain shape, and relative value of agricultural installation (fences, buildings, etc.). Mainstem floodplain damage evaluations are a U.S. Army Corps of Engineers responsibility and were not conducted for this study. Streams not studied include the mainstem Arkansas, Walnut, Verdigris, Cottonwood, Neosho, and Spring Rivers.

Economic study procedures - As most of the economic data was available only from secondary sources by counties, the drainage area boundaries were approximated by county lines for purposes of economic analysis. Use was made of information developed in connection with the Missouri River Basin Framework Study and economic projections made for the U.S. Water Resources Council. Estimates of projected crop yields, production costs, and fertilizer requirements were obtained from an advisory committee of Kansas State Experiment Station personnel. Much of the economic analysis was done by use of computer programs developed previously in connection with other similar studies. Economic impact analysis relied on an adaption of the input-output model developed for the State of Kansas.

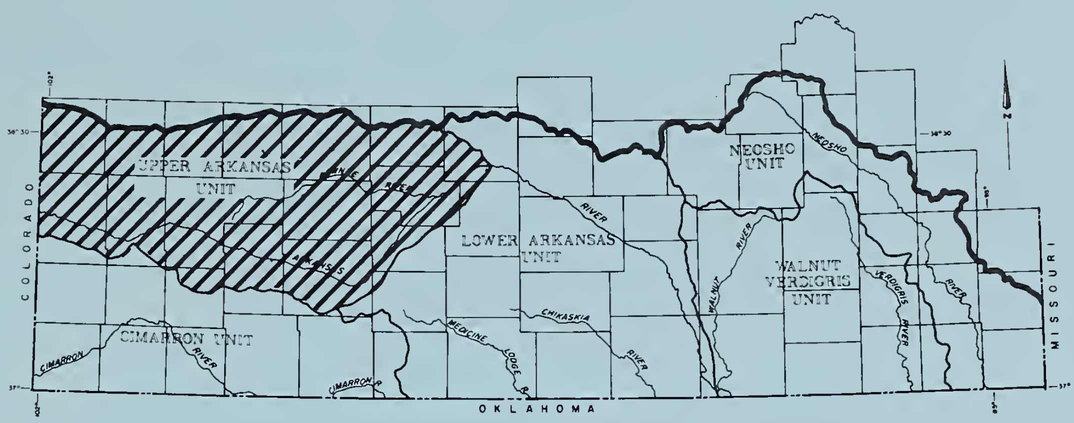
Tables and maps are grouped together as exhibits at the rear of the report. The reader may make a cursory review of report information without utilizing the exhibits. Detailed information may be found by turning to the exhibit as referenced in the narrative.

Cooperation, data, and assistance for this U.S. Department of Agriculture report were provided by the following local, state, and federal agencies and groups:

Agricultural Stabilization and Conservation Service, USDA
Farmers Home Administration, USDA
U.S. Army, Corps of Engineers, Tulsa & Albuquerque Districts
U.S. Bureau of Reclamation
U.S. Bureau of Census
U.S. Bureau of Mines
U.S. Geological Survey
U.S. Bureau of Outdoor Recreation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

Kansas Division of Water Resources
Kansas State University
Kansas State Experiment Station
Fort Hays Kansas State College
Kansas State Conservation Commission
Kansas Geological Survey
Kansas Highway Commission
Kansas Forestry, Fish and Game Commission
Kansas Park and Resources Authority
Kansas State Board of Health
Kansas Conservation Districts
State Association of Kansas Watersheds

UPPER ARKANSAS UNIT



Land Use - Cropland - 4,633,180 acres
Rangeland - 1,832,700 acres
Forest - 10,070 acres
Other - 130,650 acres

Total Area - 6,606,600 acres

Total Capability Class I, II, III, and IV Land - 5,463,000 (85%)

Irrigated Acreage - 670,000 (1971)

Average Annual Precipitation - 16 to 24 inches

Land treatment is adequate on 1,410,900 acres of cropland (30%) and 724,500 acres of rangeland (40%)

The total cost of applying needed crop and pasture land treatment is estimated to be $120,100,000

The total cost of applying needed forest land treatment is estimated to be $610,600

Floodwater and sediment damages on tributary streams average $2,200,800 annually--some 250,900 acres are subject to inundation

P.L. 566 Watershed Projects Completed or Authorized for Construction - Two

Active P.L. 566 Watershed Projects Authorized for Planning - Five

Seventeen feasible Early Action watershed projects are needed within the next 10-15 years

Two additional watersheds merit consideration for Long Range project development

UPPER ARKANSAS UNIT

NATURAL RESOURCES

Location and Size

The Upper Arkansas Unit is that portion of the Arkansas River Basin between the Colorado-Kansas state line and Great Bend, Kansas. The unit contains 10,323 square miles or 6,606,622 acres making up about 25 percent of the total basin area. The unit extends 210 miles east and west and is 95 miles across at its widest point.

Pawnee River and Walnut Creek are the two major tributaries of the Arkansas River in this unit. Whitewoman Creek and James Draw are non-contributing tributaries which drain a portion of the unit but end in depressions. Remaining areas of the unit are drained by numerous small direct tributaries of the Arkansas River. The drainage areas by major streams are:

Name	Area in Square Miles
Whitewoman Creek and James Draw	1,615
Pawnee River	2,717
Walnut Creeks	1,754
Direct Arkansas Tributaries	4,237
Total	10,323

Counties entirely within the Upper Arkansas Unit are Hodgeman and Finney. Other counties partly included are Greeley, Wichita, Scott, Lane, Ness, Rush, Barton, Stafford, Pawnee, Kearny, Hamilton, Haskell, Gray, Ford, Edwards, and Kiowa. (Exhibit 1)

Climate

Change and extremes are dominant characteristics of the climate. Weather is often the topic of conversation and one often hears "If you don't like the weather, just wait a minute!" Moisture laden air originating in the Gulf, hot, dry air coming from the desert southwest, and cold Arctic air masses are responsible for the changeable and

often exciting weather patterns. Climate in the western half of the unit is semi-arid continental. The eastern half is subhumid continental.

Average yearly precipitation ranges from 16.0 inches at Syracuse to 23.5 inches at Great Bend. (Exhibit 2) Precipitation varies widely from year to year, but it is generally inadequate for optimum growth of most crops. In addition, the kinds of non-irrigated crops that can be grown successfully are limited because average evapotranspiration is considerably higher than average precipitation. Normally, three-fourths of the annual precipitation falls during the six month period of April through September. Rainfall decreases through August and September, and occasionally soil moisture is inadequate for planting of winter wheat and other fall sown crops.

In periods when rainfall is heaviest, much of it comes in showers and thunderstorms. As much as twelve inches of rain accompanied by hail fell northwest of Ness City in a 4-hour period during May 1967. Thunderstorms can be expected 50 to 60 days during each year. A few storms are accompanied by high winds and hail. Generally only small local areas are damaged by hail.

Snowfall is light in most years. The average for central areas of the unit is about 20 inches annually. Blizzards occur occasionally but they are usually of short duration. Snow usually does not remain on the ground long.

Droughts are often severe and occasionally several successive years are drier than normal. Droughts were especially severe during the periods 1931-1940 and 1952-1957. In addition to the hazard of drought, hot, burning winds affect the area.

Two years out of 100 annual lake evaporation will exceed the normal annual value by 25-30 percent. Average annual lake evaporation ranges from 58-63 inches in this unit.

Records kept for the weather station near Lakin, Kansas, in Kearny County indicate average January and July temperatures of about 31 degrees and 80 degrees respectively. Extremes in temperature range from 112 degrees, recorded July 13, 1913, to -23 degrees, recorded January 5, 1942.

Records for other weather stations in the unit show similar temperature patterns. The average length of frost-free period ranges from 162 days in Greeley County to 174 days in Barton County. Freezing temperatures at Lakin were recorded as late as May 27 and as early as September 17.

A newcomer to this area will notice the persistent, southerly winds. Records at the weather station at Dodge City show an average annual wind velocity of about 15 miles per hour. Winds of at least 56 miles per hour have been recorded for every month of the year. Persistent winds and low rainfall increase the hazard of soil erosion and can result in dust storms.

Topography

The Upper Arkansas Unit lies in three physiographic sections, the High Plains section, the Dissected High Plains section, and the Arkansas River Lowlands section. The High Plains section covering most of the western two-thirds of the unit is a flat to gently rolling upland with a few shallow valleys and many shallow, undrained depressions.

HARVESTING GRAIN SORGHUM IN THE HIGH PLAINS SECTION IN WICHITA COUNTY.

The Dissected High Plains section in the eastern portion of the unit is characterized by hilly topography. The Arkansas River Lowland section includes the Arkansas River valley and terraces, the lower valleys of the Pawnee River and Walnut Creek, and the sand hill areas adjacent to the Arkansas River. The topography of the lowland section is flat with the exception of the sand hill areas. Land surface elevations range from approximately 3,900 feet above sea level in Greeley County to 1,850 feet in Barton County.

Geology and Soils

Rock outcrops of the Upper Arkansas Unit are of sedimentary origin. Ages of the rock formations include Cretaceous, Tertiary, and Quaternary. The Lower Cretaceous includes the Dakota Formation which is an important aquifer in the Dissected High Plains section. The Upper Cretaceous series includes the Graneros shale, Greenhorn limestone, Carlile shale, and Niobrara chalk. In general the area of Cretaceous outcrop is in the Dissected High Plains section of Hodgeman, Rush, and Ness Counties.

POINT OF ROCKS, AN OGALLALA FORMATION IN THE DISSECTED HIGH PLAINS SECTION, HODGEMAN COUNTY.

The Ogallala Formation of the Pliocene series (Tertiary Age) consists of unconsolidated gravel, sand, silt, and clay of fluviatile origin. The formation with a maximum thickness of 300 feet underlies 80 percent of the unit. It crops out along Whitewoman Creek and along the western edge of the Upper Cretaceous outcrop.

Pleistocene loess of Quaternary Age mantles most of the unit. The cover of unstratified aeolian silts thins over the Cretaceous bedrock in Ness, Hodgeman, and Rush Counties. Under the loess in the western half of the unit are sand and gravel deposits also of the Pleistocene series. The lower part is generally water saturated and in contact with the Ogallala Formation.

Sand dunes cover over 50 percent of the area south and east of the Arkansas River. Alluvium and terrace deposits constitute the valley fill of the Arkansas and Pawnee Rivers and Walnut and Whitewoman Creeks.

The nearly level and gently sloping upland consists predominantly of deep, well drained loamy soils formed from loess. (Exhibit 3) Slowly permeable clay soils are in the depressions that pond water. Most of the sloping soils along drainageways are deep, well drained, loamy soils formed in calcareous loamy outwash. Along the major stream valleys there are some moderately deep and shallow soils on the steep slopes. South of the Arkansas River is an extensive area of sand hills. Adjoining the sand hills on the south are sandy soils on undulating to hummocky topography. On the bottomlands there are clayey, loamy, and sandy soils but loamy soils are predominant. The soils on bottomland range from poorly drained to well drained. The soils in the depression area north of Garden City and some of the soils in the Arkansas River valley are affected by salt and alkali.

Minerals

Mineral production is the second most important industry in the unit. (Exhibit 4) In 1960 mineral production was estimated at $38,000,000. About 88 percent of this value is attributed to oil and gas. The Hugoton gas field extends into Kearny, Finney, and Haskell Counties. Oil fields are scattered over the unit. A large oil producing area lies in northwest Stafford County and extends into eastern Pawnee County and southwestern Barton County. Other minerals of

lesser importance are clay, stone, salt, volcanic ash, sand, and gravel.

High grade ceramic clays are found in Hodgeman and northern Ford Counties. All counties have an abundance of sand and gravel. The unit, with exception of Greeley, Scott, Wichita, and northwest Finney Counties, is underlain with thick salt beds. Limestone quarries are located in Rush, Pawnee, Ford, Hodgeman, and Ness Counties. Small deposits of volcanic ash are found in Ness County. Mineral processing plants for oil, gasoline, helium, brick, and salt are operating in the producing areas.

Land Use and Management

The Upper Arkansas Unit is within the Central Great Plains Winter Wheat and Range Region of the United States. It contains parts of four major land resource areas: area 72, the Central High Tablelands; area 73, the Rolling Plains and Breaks; area 78, the Central Rolling Red Plains; and area 79, the Great Bend Sand Plains. (Exhibit 5)

Land use for each land resource area in the Upper Arkansas Unit is as follows:

Land Resource Area	Cropland		Rangeland		Forest		Other		Total
	Acres	%	Acres	%	Acres	%	Acres	%	Acres
072	3,768,809	69	1,585,441	29	3,937	<1	96,404	2	5,454,591
073	674,526	77	168,639	19	5,166	1	25,934	3	874,265
078	5,812	30	13,141	67	101	<1	581	3	19,635
079	184,034	71	65,487	26	866	<1	7,744	3	258,131
Total	4,633,181	70	1,832,708	28	10,070	<1	130,663	2	6,606,622

Land use for the unit by land capability class is shown in the following table:

Land Capability Class	Acres by Land Use				Total
	Cropland	Rangeland	Forest	Other	
I	28,283	3,379	2,216	985	34,863
II	2,411,987	322,403	54	57,914	2,792,358
III	1,594,777	249,284	3,108	30,969	1,878,138
IV	503,573	238,642	161	15,268	757,644
V	201	13,865	95	109	14,270
VI	91,552	692,579	3,361	14,495	801,987
VII	2,808	312,556	1,075	10,923	327,362
VIII	0	0	0	0	0
Total	4,633,181	1,832,708	10,070	130,663	6,606,622

Over five million acres or about 83 percent of the total area within this unit is in land resource area 72. Nearly all this area is in farms and ranches. Sixty-nine percent of the area is cropland, of which 11 percent is irrigated. Winter wheat is the main cash crop. Grain sorghum is the only other crop utilizing any large acreage. Corn and grain sorghum are the principal irrigated crops.

Rangeland accounts for 29 percent of land resource area 72 in this unit. On the hardland areas, shortgrasses such as buffalograss and blue grama are predominant species. During periods when moisture conditions are favorable, increases in midgrasses such as western wheatgrass and sideoats grama may occur. Tall and midgrasses occupy the sandy range sites. Sand and little bluestem, sand lovegrass, and switchgrass are common in these areas.

Cities and towns, roads, highways, railroads, water areas, and other non-agricultural land uses account for twc percent of land resource area 72. Forests account for less than one percent of the area.

Land capability classes within land resource area 72 range from II through VII. Eighty-one percent of the area is classified as II, III, or IV and 83 percent of this is utilized for crop production. Climate, specifically the low annual precipitation, restricts the better lands from a capability class I designation.

The northeast portion of the unit lies in land resource area 73, the Rolling Plains and Breaks. Thirteen percent of the unit is accounted for in this land resource area. Land use consists of 77 percent cropland, 19 percent rangeland, 1 percent forestland, and 3 percent other. Only 2 percent of the cropland is irrigated. Wheat and grain sorghum are the major dryland crops and corn and grain sorghum the principal irrigated crops.

A large part of the rangeland in land resource area 73 consists of breaks along the major streams and their tributaries. Sideoats grama, blue grama, and little bluestem are the predominant grasses found in the breaks area. Those grasses found on the hardland areas and sandy areas, as mentioned for land resource area 72, are predominant in this area also.

Cities and towns, roads, railroads, water areas, etc. make up the three percent of land listed as other in land resource area 73.

Land capability classes I through VII can be found in the Rolling Plains and Breaks area of the unit. Fifty-nine percent of this area is classified as land capability class III of which 83 percent is cropland.

Land resource area 78, the Central Rolling Red Plains, accounts for 19,635 acres or 0.2 percent of the total Upper Arkansas Unit. Sixty-seven percent of the area is rangeland, 30 percent cropland, and 3 percent other. The principal native grasses found in this area are the same as those of land resource areas 72 and 73. Wheat, grain sorghum, and alfalfa are the major crops of this area.

The southeast area of the unit is within land resource area 79, the Great Bend Sand Plains. Only 4 percent of the unit lies within this resource area. Rangeland occupies 26 percent of the area. Those native grasses found in land resource areas 72, 73, and 78 are the major species found

in this area. Cropland represents about 71 percent of the total area. Wheat, grain sorghum, and alfalfa occupy the major portion of the cropland area. Only 1 percent of the cropland is irrigated. Corn and grain sorghum utilize most of the irrigated acreage.

The remaining land in resource area 79 is utilized for resources other than those direct agricultural uses.

Water Resources

Surface Water - At the present time there are ten continuous record stream-gaging stations within the unit which provide streamflow information about the Arkansas River and four tributaries. The Whitewoman Creek near Leoti, Mulberry Creek near Dodge City, Guzzler's Gulch near Ness City (Pawnee River tributary), Walnut Creek near Rush Center, and Walnut Creek at Albert stations have been in operation only a short time. In addition to the full-time gaging stations, data are collected at nine partial-record stations.

Average annual runoff across the unit varies much more than does precipitation. Normal annual rainfall ranges from over 23 inches at the eastern end to 16 inches at the western boundary. (Exhibit 6) By comparison the average runoff ranges from 0.8 inch in the east (3.5 percent of the precipitation) to 0.1 inch in the west (0.6 percent of the precipitation). This analysis shows average runoff to decrease nearly six times faster than average precipitation from east to west across the unit.

Variability of annual flows are typified by extremes of record for the Pawnee stream gage. Records for the Pawnee gage have been collected since 1924. Drainage area contributing to streamflow is about 2,010 square miles. In 1951 flow totalled 358,200 acre feet. Only 7,250 acre feet of flow passed the gaging station in 1926. These extremes vary widely from the average annual runoff of 58,900 acre feet.

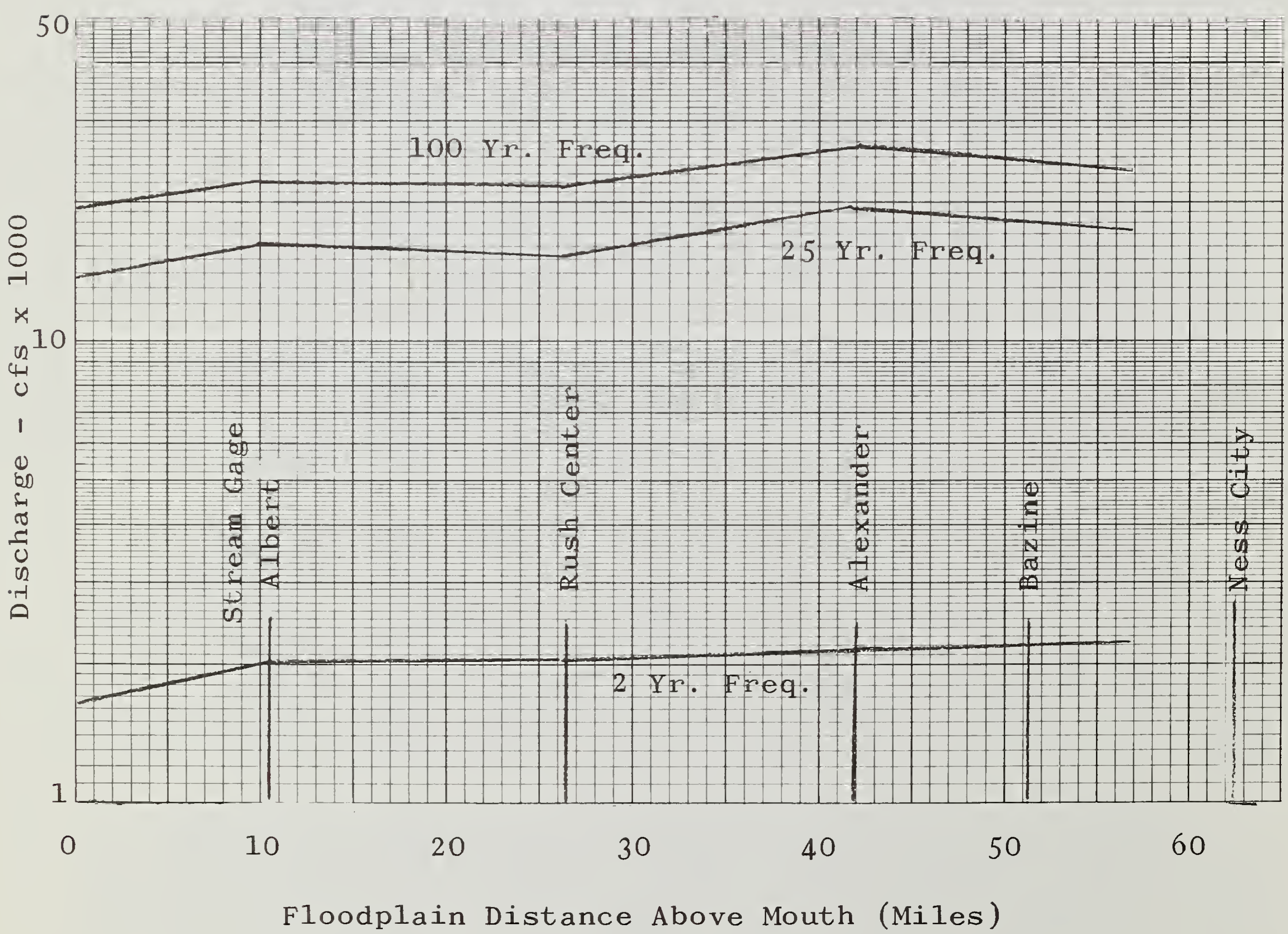
Flood flows along the Arkansas River in this unit tend to decrease in magnitude from the Colorado-Kansas state line downstream to below Kinsley. Some tributary streams of the unit have been observed to share this characteristic for many storms. It is normal for flood peaks along any stream

to decrease with distance downstream from the area of precipitation. However, on some streams of the unit the factors affecting flood peaks combine to reduce peaks after a maximum point is reached somewhere along the stream, even for storms of general watershed coverage. These factors are long, narrow, watershed shape; large valley storage potential; and channel and floodplain infiltration. A plot of synthesized flood peaks (assuming general storm coverage) along the mainstem of Wet Walnut Creek reveals this trend.

Wet Walnut Creek

Discharge vs. Distance Above Mouth

for 2 yr., 25 yr., and 100 yr. Frequency



Hydrologic studies also reveal that the estimated 100 year frequency flood event has not occurred during the period of stream gaging on Wet Walnut Creek or Pawnee River. (Exhibit 7)

Localized high intensity rain storms have produced flash flooding many times on tributary streams. Every few years, somewhere in the unit, one of these events exceeds all flood marks remembered by local residents. One recent example of the flood producing potential of these flash storms occurred in the late hours of May 30 and early morning hours of May 31, 1967. In a 4-hour period 4 to 12 inches of rain, accompanied by hail, fell over a 150 square mile area northwest of Ness City. The flood peak produced on the North Fork of Wet Walnut at Ness City exceeded the highest known previous mark by about six feet. Estimates of the peak discharge for this flood at Ness City exceed 50,000 cfs. Fairly rapid reduction of the flood peak occurred. At Bazine the peak passed at about one foot below the record 1959 level. Peak discharge for this flood at the stream gage near Albert was 2,800 cfs or just above bank full.

THIS ROAD WASHOUT OCCURRED IN THE MAY 1967 FLOOD IN NESS COUNTY.

Little use is presently made of Arkansas River water other than for irrigation above Garden City and for the transportation of wastes. Quality of water in the river is very poor by U.S. Public Health Service drinking water standards, and there are possible hazards to crops when used for irrigation purposes. (Exhibit 6) The high concentration of dissolved solids and sulfates is attributed, at least in part, to the continual reuse of the water for irrigation as it passes through Colorado and Kansas. Irrigation has been practiced along the Arkansas River in Kansas since 1879. It can be seen from early records that water quality was poor, even as early as 1906-07. A comparison of early and present day records shows some increase in dissolved solids and sulfates. According to a classification of irrigation waters developed by Kansas State University, water in the Arkansas River has a high to very high salinity hazard and a low to medium sodium hazard for medium textured soils. It is necessary to prevent excessive accumulation of salts in the root zone of the soil or crop growth and yields will be decreased. On sandy soils, such as those generally occurring along the Arkansas River, the salinity hazard is reduced as salts are more easily removed by leaching than on finer textured soils. Accumulation of salts in the root zone of the soil could become a problem with continual use of Arkansas River water for irrigation.

Streams in the Upper Arkansas Unit have suspended sediment loads, consisting mostly of clay and silt with some sand. (Exhibit 6) Bed loads are sands and coarser materials. Sediment samples are presently being collected at four gaging points on the Arkansas River, one on the Pawnee River near Larned, and one on Wet Walnut Creek near Albert. Based on available records, the discharge-weighted sediment concentrations are estimated to be less than 2,500 ppm for the Arkansas from the state line to Larned and in the 2,500 to 3,500 ppm range from Larned to Great Bend. Concentrations are probably in the 3,000 to 4,500 ppm range for Pawnee River and Wet Walnut Creek.

Groundwater - The availability of groundwater is dependent upon the geology of the area. (Exhibit 22) The principal sources of water are the alluvium and terrace deposits, undifferentiated Pleistocene deposits, Ogallala Formation, and Dakota Formation. A brief description of these aquifers follows.

Alluvium and terrace deposits of Pleistocene Age are prevalent in major stream valleys. They are important aquifers where other deposits are not available. The saturated thickness of the alluvium ranges from zero to 100 feet in the Pawnee valley. The saturated thickness of the alluvium in the Walnut Creek valley is not as great as along the Pawnee valley.

The undifferentiated Pleistocene deposits of sands and gravels in direct contact with the Ogallala Formation will be discussed as one continuous unit. The saturated thickness in the western part of the unit ranges up to 400 feet. (Exhibit 24) A major portion of the volume of water lies in Scott, Kearny, Finney, Gray, Haskell, and Ford Counties where the deposits are thickest. The U.S. Geological Survey has estimated that the groundwater in storage available to wells may be as great as 80,000,000 acre feet.

The Dakota Formation of Cretaceous Age includes sandstone aquifers. Yields as well as quality vary over the unit. In some areas the sandstone aquifers supply sufficient water for municipal, domestic, and livestock use. The aquifers are important in the eastern one-half where Pliocene and Pleistocene deposits are not available.

The Cheyenne sandstone yields water to a few wells in the extreme western part of the unit. The yield is small to moderate and at moderate depths.

Fish and Wildlife Resources

Sport fishing in the Upper Arkansas Unit is limited to warm-water species. The streams are noted for channel catfish and in some areas black bullheads and carp are important. (Exhibit 9)

Largemouth bass, white bass, black crappie, white crappie, bluegill, carp, drum, channel catfish and black bullhead are the major species found in the small reservoirs and farm ponds. The Soil Conservation Service reported in July 1967 approximately 1,950 farm ponds in the Upper Arkansas Unit. The majority of these ponds are in the northeastern part of the unit. Greeley County in the northwestern part of the unit has the least number of ponds with a total of 22. There are seven small reservoirs in the Upper Arkansas Unit having a

total surface area of 3,738 acres of water at normal pool levels. (Exhibit 8)

THIS FARM POND IN NATIVE RANGELAND IN FINNEY COUNTY IS USED BOTH FOR STOCKWATER AND RECREATION.

The semi-arid climate of the Upper Arkansas Unit restricts vegetative growth and limits the habitat available for many species of wildlife. Some species are suited to the dry conditions. Species found in the Upper Arkansas Unit are whitetail and mule deer, pheasant, quail, dove, cottontail and jackrabbit, fox squirrel, and waterfowl. (Exhibit 10) Deer are the only big game species harvested in the Upper Arkansas Unit. Populations of antelope and Rio Grande turkey are increasing and with proper habitat and species management it is anticipated their numbers will increase to levels that will permit harvesting. The more predominant fur bearers of this area include mink, muskrat, beaver, raccoon, and coyote. Red and swift fox populations are also present. Populations of black-tailed prairie dogs and associated species are present in scattered dog towns throughout this area.

Pheasants are the most important upland game bird harvested in the unit in terms of total numbers taken and man-days of recreation provided.

The Upper Arkansas Unit is located within the Central Flyway and numerous species of waterfowl pass through the area during spring and fall migration. Lake McKinney is the only large body of water in the Upper Arkansas Unit providing a resting and over-wintering area for migrating waterfowl. Streams and ponds across the unit also provide resting and feeding areas. During wet years, marshy areas and pot holes are utilized by migrating waterfowl.

In November 1970, lesser prairie chickens were added to the list of harvestable species. The Bureau of Sport Fisheries and Wildlife lists the lesser prairie chicken as a rare wildlife species in the United States.

Important to other wildlife enthusiasts is the fact that an over-wintering population of eagles (bald and golden) is present each winter along the Arkansas River. Many additional species of small animals and birds are present and are important from an ecological and esthetic standpoint.

Forest Resources

Commercial forest acreage accounts for approximately 9,000 acres out of a total of 6,606,622 acres in the unit. All of the commercial forest land is under private ownership. Noncommercial forest acreage totals 1,000 acres. (Exhibits 11 and 12) The hardwood forest types - elm, ash, cottonwood, bur oak, and hackberry - comprise most of the commercial timber stands. (Exhibit 13) The natural woodlands of the area are found principally in narrow belts along the river valleys and side drainages.

The unit's commercial sawtimber supply in 1965 contained nearly 18 million board feet measured by the International 1/4-inch rule. In addition, there are about 11 million cubic feet classified as forest growing stock. These volume figures do not include that of dead and cull trees. (Exhibit 14)

Of the total sawtimber volume (18 million board feet) 56 percent is cottonwood, 15 percent bur oak, and 14 percent elm. Other hardwoods include ash, hackberry, and black walnut. The average sawtimber volume per acre of sawtimber stands is approximately 2,000 board feet.

Heavy grazing, burning, and/or poor markets for forest products have resulted in an accumulation of sawtimber

stands. Over half of the growing stock volume is in sawtimber trees. The stands contain many cull trees and too few growing stock trees. The area's timber cutting is at a low level and despite the high growth rate, yield is small as a result of the low growing stock volume. Timber harvested from sawtimber and growing stock on commercial forest land in 1964 amounted to 109,000 board feet, International 1/4-inch rule. (Exhibit 15) Fuelwood accounted for 108,000 board feet. The remaining 1,000 board feet was cut for fence posts. Improved demand and more markets are expected to increase the cut to equal growth of sawtimber by the year 2020.

Most of the unit is favorable for timber growth. The river valley areas have rich soils and a long-growing season. However, sawtimber growth has been slow due to the drought of the 1950's which killed many trees. Losses were especially high in larger trees that had already been damaged by fire, disease, and insects. A large amount of growing space is now occupied by brush or poor trees that restrict growth of desirable trees.

Currently, there are no wood-using establishments in the unit.

Quality of Natural Environment

What has man done to this land? Has he exploited its resources for his personal gain and added nothing in return? An answer to these questions may be found by comparing accounts of the environment found by early settlers to that existing today.

Most stories of pioneer life agree on the absence of landmarks in this area. The rolling grassy plains were open as far as the eye could see with only an occasional draw or creek to break the monotony. Even these drainageways looked much alike to all but the experienced guide or traveler. It was easy to get lost, even when travelling short distances. Settlers would plow a furrow from their dugout or "soddy" to their neighbors so that the women and children would not get lost when visiting.

The winds had little to slow their flight across the treeless plains. Snows were driven in awesome, deadly blizzards. Prairie fires could burn unchecked for miles,

driven by the wind, with nothing to stop them except the Arkansas River on the south or the Smoky Hill River to the north. These fires destroyed the wildlife, the few trees that had escaped previous fires, and the protective cover that offered the only resistance to erosion.

Man has changed the environment. The forest strips along the rivers and streams are broken by grain fields, pastureland, and hay fields, adding color and variety to the landscape. Rows of trees provide added greenery and shelter to farmsteads. Irrigation and moisture conserving conservation practices add a new depth to the green of spring and summer months. Rangeland provides a reservoir of clean air and open spaces. Fires can no longer sweep across the prairies because of the interspersed cropland fields. Wildlife abounds because of improved protective cover, new food sources, and wildlife management practices.

The farmer did not accomplish this balance between his needs and nature's demands without some difficulty. He learned through mistakes. He learned how to cultivate the soil without exposing it to eroding wind and water. Stubble mulch tillage and terraces not only protect while enhancing production but also add a beauty and symmetry to the land. The farmer has long been aware of the need for preservation of his environment.

The broad expanse of agricultural land is punctuated by small cities and towns. They provide a friendly community life with little of the pollution associated with our nation's larger cities. Business places and residences are usually well spaced. Streets are tree lined and a neat park is usually close at hand. The green and shady court house square adds beauty to the downtown area of many of the county seats. An unseen quality of this environment is the absence of fear to walk the streets alone at night.

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

Watershed Protection and Management

Erosion and Sediment Damage - Wind and water are the principal active forces causing soil erosion in the Upper Arkansas Unit. Wind erosion is always a hazard and is serious on the High Plains and sand dune areas during recurring periods of drought. Water erosion is a hazard on all sloping soils that are cultivated or overgrazed. Slight erosion from runoff has occurred on the nearly level tablelands.

THIS IS A BLOWOUT AREA IN A SAND RANGE SITE IN GRAY COUNTY.

SOIL EROSION ON 3 TO 6 PERCENT SLOPE IN FINNEY COUNTY.

Grade stabilization problems in the unit are minor and may be solved through individual action with on-farm land treatment measures.

The rate of water erosion is affected by land slope, soil texture, land use, and rainfall intensity. Sediment, the product of erosion, fills farm ponds and reservoirs and may be detrimental to the soil when less fertile sediments are deposited on fields. Coarse textured sediments are deposited on the floodplains along the Arkansas River while fine textured sediments are deposited along tributary streams.

Sediment yields may be as great as 0.75 acre feet per square mile per year depending on the physical conditions of the contributing watershed. (Exhibit 16) The level plain and flat sandy areas may yield 0-0.1 acre feet per square mile per year while slopes on rolling land in Rush

County generally yield 0.25-0.50 acre feet per square mile annually.

Land Treatment Needs - Current conservation treatment adequately meets the conservation problems on 26 percent of the 3,768,809 acres of cropland in land resource area 72. (Exhibit 17) Residue management, mainly stubble mulching, and stripcropping are the principal dryland land treatment practices needed. Stubble mulching is needed to reduce soil loss from wind and water and to improve water infiltration and the physical condition of the soil. Stripcropping reduces wind velocity at the soil surface thereby reducing soil blowing and damage to crops. The major irrigated land treatment need is planned irrigation systems to efficiently convey and distribute water without excessive erosion or water losses.

STUBBLE MULCHING IN NORTHEAST HASKELL COUNTY.

CONTOUR STRIPCROPPING CHECKS WATER AND WIND EROSION IN HAMILTON COUNTY.

Treatment is adequate on 42 percent of the rangeland in land resource area 72. Proper grazing use is the most needed practice. This practice will result in increased vigor and reproduction of key plants, increased litter and mulch necessary to conserve soil and water, improved condition of the vegetation, increased forage production, maintained natural beauty, and reduced fire hazard. In order to reduce competition of woody plants and establish a better cover for soil protection and forage production, brush control is needed on 226,629 acres. Range seeding is needed on 14 percent of the rangeland. Seventy percent of the area that should be seeded requires brush control before seeding. This would increase forage production, prevent excessive soil and water losses, and improve the natural beauty of the grazing lands.

The land treatment problems have been adequately solved on 49 percent of the cropland acres in land resource area 73. Terracing and stubble mulching are the most needed land treatment practices. Eight percent of the cropland needs stubble mulching and 40 percent needs terracing. Terraces are needed to conserve moisture and control erosion.

Only 14 percent of the rangeland in land resource area 73 has been adequately treated. Proper grazing use is needed on 139,708 of the 168,639 acres.

Land treatment measures are adequate on 41 percent of the cropland acres within land resource area 78. The

application of terracing, stripcropping, and residue management will provide adequate treatment on all but 6 percent of the area.

Over two-thirds of all the rangeland in land resource area 78 is adequately treated. To be adequately treated, proper grazing use needs to be practiced on 27 percent of the rangeland.

In land resource area 79, a total of 72,326 out of 184,034 acres of cropland have been adequately treated. Stubble mulching and terracing will solve the conservation problems on the area needing treatment. Irrigation water management is the principal conservation practice needed on the irrigated land.

Treatment is adequate on 38 percent of the rangeland in resource area 79. Over half of the area requires proper grazing use in order to be adequately treated. Brush control and range seeding is needed on 10 percent of the area.

Woodlands - The general discussion beginning on page 192 also applies to the watershed protection and management needs of woodlands in this unit. These needs are quantified on page 69.

There is light to heavy grazing of the woodlands. In most instances, trees in these stands have plenty of growing space, however in some areas they are competing with brush or cull trees. These areas are often occupied by grass or other vegetation that inhibits restocking of trees. Planting is necessary to improve the stands.

There is a distinct need for more woodland development for recreation, scenic, and wildlife uses.

Floodwater and Sediment Damages

Floodplain damages discussed herein are those occurring on tributary streams. Mainstem Arkansas River flood damages were not evaluated except where identifiable in the immediate vicinity of a tributary outlet. (Exhibit 18a)

Two distinct types of streams are noted when evaluating tributary floodplain damages. The most common type is those streams with channels that outlet into the Arkansas River,

for example: Wet Walnut Creek, Pawnee River, and Syracuse Creek, near Syracuse. Less common are those streams that end in a depression area. These include Whitewoman Creek and James Draw. A quote from the James Draw Watershed Investigation Report describes the latter type of flood problem. "Flood flows, after leaving the relatively narrow confines of James Draw, spread across the irrigated acreage of northwest Finney County. A continuous channel does not exist across these lands. Other smaller draws also add floodwater to the damaged area. Velocity of flow is relatively high due to 10 to 15 feet per mile natural slope to the east. Flows are generally shallow until they collect in pot holes of the Scott-Finney depression."

Agricultural areas suffer the greatest flood damage. An estimated 250,916 acres along tributary streams are subject to inundation by a 100-year frequency flood (a flood which has a one percent chance of occurring in any given year). Some 181,663 acres of cropland, 60,471 acres of pasture, and 8,782 acres of miscellaneous use (including channel and adjoining timber) would be inundated by this size flood. (Exhibit 18) 85,400 acres of the cropland are currently being irrigated. Estimates of irrigation potential on these floodplain lands exceed 100,000 acres.

Average annual crop damages based on 1980 projections are estimated to be $1,463,400. Factors influencing crop damages are floodplain area and shape, gross value, and season and frequency of flooding. Gross value depends upon land use and productive capacity of the soils.

Other agricultural flood damages include flooding of stored grain and hay, fences, farm buildings, and farm machinery. Included as other agricultural damage in this unit is damage to land that has been leveled for irrigation. This item reflects re-leveling costs and costs of cleaning out and repairing ditches and head structures. Other agricultural damages average $279,900 annually within this unit.

Annual floodplain scour and sediment damages are estimated to average $61,600. Such damages have occurred on about 6,340 acres of floodplain lands.

Total agricultural damages are $1,804,900 on an average annual basis.

Non-agricultural floodwater damage includes damage to roads and bridges, railroads, oil fields, and urban areas. Road and bridge damage is the major item in this category averaging $123,700 annually. Road and bridge damages occurring at crossings of upland draws and gullies were not evaluated but probably total more than that occurring along floodplains.

Railroad damage is relatively minor in the evaluated area. Twenty-eight miles are affected to the extent of $13,300 on an average annual basis. Oil field damage is also minor totaling $300.

Urban floodwater damage totaling $51,200 annually was evaluated in the following towns: Cimarron, Lakin, Bazine, Nekoma, and Timken. Damages by flooding are primarily interruption of business, cleanup of sediment and debris, and loss in valuation of property. Damages to the city of Great Bend also occur from Wet and Dry Walnut Creeks but are included in Corps of Engineers evaluations.

Total non-agricultural damages are estimated to be $188,500 on an average annual basis.

Indirect damage is estimated to average $207,400 annually. Indirect losses include interruption of transportation and utilities and loss of business to those serving agricultural communities.

Total evaluated tributary floodplain damages, including agricultural, non-agricultural, and indirect losses, are estimated to average $2,200,800 annually.

<u>Agricultural Water Management</u>

Drainage - Problems encountered were those of surface water removal. A large portion of this unit is nearly flat tableland that slopes 10-15 feet per mile to the east. The surface of this land is marked with many shallow pot holes. Drainage is indefinite, generally leading surface runoff overland and along road ditches until it collects in depressional areas or "pot holes". A portion of water collected in pot

holes is added to groundwater but most is lost to evaporation because of the large surface area to depth ratios and relatively impermeable soils. In some years crops cannot be grown in these pot holes due to the long duration of flooding.

Lack of a defined stream pattern on the widely irrigable tableland presents problems in tailwater removal. Reforming land during the irrigation development process concentrates excess water at the lower end of fields. If no outlet is provided, excess water may flow onto neighboring fields. This problem is sometimes solved by making use of natural pot hole storage.

Natural and man-made dikes along some streams of the unit have caused some localized surface water removal problems. Many of these problems have been solved by individual action. Most of the remaining problems could also be solved in the same manner. No wide spread floodplain drainage problems requiring project type solution were encountered.

The 1967 Conservation Needs Inventory places the remaining cropland drainage problem area size at 7,722 acres.

Irrigation Demands - In this unit irrigation uses considerably more water than all the other uses combined ranging from fifteen times as much at present to an estimated twenty-six times as much by the year 2020. (Exhibits 19, 26, and 31)

Irrigation is extremely important in this area of marginal precipitation. The Kansas Water Resources Board estimated that each acre foot of water used for irrigation in southwest Kansas increased income by about $30 in 1966. In 1969, there were an estimated 1,880,000 acre feet of water used to irrigate 630,000 acres in the Upper Arkansas Unit. At $30 an acre foot, this gave an increase in income of $56 million due to irrigation.

Most of the irrigation is with groundwater. This unit has large supplies of underground water and a considerable amount of land suitable for irrigation. (Exhibits 20, 21, and 22) The location of tracts which had water rights for irrigation in 1966 gives an indication of where the irrigation development is taking place. Irrigation acreage and water demand are expected to increase greatly in the next 50 years. Areas having land suitable for irrigation and adequate water supply are where irrigation development may be expected.

Groundwater Depletion - The aquifers which are not supplying adequate well yields for irrigation have limited replenishment. The total annual demand is greater than the annual recharge and thus the amount of groundwater in storage is being depleted. (Exhibits 23 and 24) At the present rate of development and level of water management, a large part of the area will no longer support irrigation by the turn of the century.

Surface impoundments for irrigation use are generally not practical in this unit (see page 61). There are one or two locations on the Arkansas River above Garden City where it may be feasible to build a major reservoir which could store water for irrigation as well as for other purposes.

Conservation of the groundwater reservoir by every feasible means is a primary need. More land treatment, such as level terracing, is needed to conserve runoff. In some areas, it may be feasible to store surface water under ground by artificial recharge if formidable technical difficulties can be overcome.

There is a great need for programs which will help speed the widespread adoption of efficient water-saving irrigation techniques. Expansions and innovations in the Soil Conservation Service Irrigation Management Program are needed to make it more generally applicable. Efficient water use can greatly increase the life of the aquifer.

The quality of the surface water in the Arkansas River is highly variable and often contains more chlorides than desirable for irrigation, particularly during low flow periods. (Exhibit 6) Except for some groundwater taken from the alluvium of the Arkansas River, the groundwater quality is generally acceptable for irrigation. (Exhibit 22)

Rural Domestic and Livestock Water - At the present time the livestock water demands are slightly more than the rural domestic needs. They are expected to go up rapidly in the future while rural domestic demands decrease slightly. (Exhibits 26 and 31) The rural population density of the unit ranges from 1 to 4 persons per square mile. This is not expected to change much in the future. (Exhibit 27)

Livestock feeding operations have changed drastically in the last decade with the introduction of large concentrated feedlot operations. (Exhibit 28) A lot feeding several thousand head of cattle requires considerable water. For example, a ten thousand head lot would need 200,000 gallons of drinking water per day or a well pumping approximately 140 gallons per minute full time. Some lots are using several times this much for control of dust and odors.

Generally, the groundwater supply is adequate in both quality and quantity to meet rural household and livestock needs. Household requirements are met almost exclusively from wells while about 90 percent of the livestock water needs are supplied from the same source. The remaining 10 percent of livestock water is supplied by ponds, springs, and streams. Special measures will be needed during severe drought periods to meet probable shortages.

THIS LIVESTOCK WATER DUGOUT IN EDWARDS COUNTY GOES DOWN INTO THE WATER TABLE IN FINE SANDY LOAM.

Non-Agricultural Water Management

Municipal and Industrial Water Needs - All municipalities and industries in the unit use groundwater. (Exhibit 27)

The only sizable future municipal water demands are Garden City and Dodge City, both requiring nearly 10,000 acre feet per year. (Exhibits 26 and 31) Generally, the groundwater supplies are of adequate quantity and satisfactory quality for municipal use. (Exhibit 22)

Several counties will have industrial water demands considerably higher than other uses. Industrial water demands include mining, manufacturing, and utilities. The highest demands are in the mining industry, which in the Upper Arkansas Unit consist mostly of petroleum and natural gas production. Because considerable reduction in the production of oil and natural gas is expected over the next 50 years, the industrial demand flattens between 1980 and 2000. (Exhibit 19) By the year 2020, other mining -- primarily sand and gravels and other non-metallic production -- will have offset the reduction in petroleum and natural gas production. Groundwater supplies should be adequate to provide the industrial demands even if supplies should become too low to support irrigation.

Recreation - The recreation water needs are based strictly on the present and estimated future population in each county. Comparing available recreation areas with recreation demands within a single county may indicate a considerable need or surplus for that county. (Exhibit 29) However, adjoining counties may have surpluses or deficits which balance out the totals over a multi-county area. For example, Wichita County shows a deficit for boating at the present time, but adjoining Kearny County shows considerable surplus in boating supply because of Lake McKinney. (Exhibit 8)

By 1980, in the Upper Arkansas Unit, there will be a need for more water area for swimming. (Exhibit 30) By the year 2000, more fishing water will be needed and by 2020 more camping areas will be needed. Probably the greatest shortage for recreation in this unit is for water area suitable for sailboating, water skiing, and high speed pleasure boating. Lake McKinney and Cedar Bluff Reservoir, which is

actually out of the unit, are the only available bodies of water where these activities are permitted since boating on most state lakes is restricted to fishing purposes only.

Fish and Wildlife - Access is a primary factor limiting the fishing resource. Most of the small water impoundments and the land bordering streams are owned by private individuals. Landowners are reluctant to permit access to most people as they cannot tolerate littering, traffic through crops, fence damage, etc., unless compensation offsets damages.

In addition to access problems, drought conditions also limit available fishing. Some streams and farm ponds may dry up completely during drought periods.

Development of suitable lake fishing is a problem in the Upper Arkansas Unit. There are a limited number of sites available where a relatively stable pool of water can be maintained. Large drainage areas are required to maintain pool size. The large areas produce large volumes of sediment which reduce the quality of a reservoir.

Selective harvesting of fish causes changes in the dominant fish populations of existing lakes. A proper balance of fish populations is a necessity for maximum lake production. Constant management and annual surveys are required to maintain good fishing quality in lakes.

Habitat is generally the key to maintaining populations of wildlife. Specific habitat requirements vary by species. General habitat involves providing protective cover, food, and water. The protective cover is very important. Birds need protective cover which provides: (1) nesting areas and areas for raising young, (2) protection from the elements of weather and natural enemies, and (3) travel and access lanes to feeding and watering areas.

Many practices which give maximum farm production reduce wildlife cover. Clean fence rows, lack of weedy patches, and large clean fields result in a reduced amount of cover. Tree and shrub removal, spraying activities, and overgrazing also reduce wildlife cover.

Wildlife need the protective cover along stream banks. Some species use the wooded area next to a stream as living

area exclusively while other species use it as a travel lane to the water or to travel from resting areas to feeding areas. The heavier vegetation also provides valuable winter cover.

WILDLIFE HABITAT DEVELOPMENT IN FINNEY COUNTY.

There is a need for understanding and coordination between private landowner, wildlife user, and wildlife management specialist. Exchange of information and cooperation between these three interests may result in a reduction of the many problems confronting wildlife.

Pollution

The streamflow needs to meet pollution abatement demands are estimated to be four times the combined municipal demands and the manufacturing portion of the industrial demands. (Exhibit 19) The Department of Health regulates the discharge of wastes from municipal and industrial sources. The wastes are and will be subjected to a high degree of treatment, or, in the case of oil field brines, of disposal in deep wells safely below any freshwater aquifer. Under these criteria, 50 percent of the mean annual flow will not provide enough dilution to adequately meet present pollution abatement

demands. Stricter treatment requirements or additional surface water flows will be needed in the future. (Exhibit 31) Fifty percent of the mean annual flow is used because in many areas it represents the surface water runoff volume from the total area which can be stored with feasible reservoir development. This assumption is based on the unit's needs as a whole and, of course, would vary considerably in each local situation.

Animal feedlots are a threat to water quality, particularly of surface waters. The greatest production of organic waste in the unit is from livestock. (Exhibit 32) Feedlots concentrate the pollutants generated by animal excretions into small areas where heavy rains can flush enormous amounts of oxygen-demanding wastes into a receiving stream. The organic waste production of a cattle feedlot with a capacity of 10,000 animals is equivalent to a city of nearly 100,000 persons. The population equivalent of hogs, sheep, and poultry is less, but still significant.

The control and disposal of feedlot wastes is of primary importance in safeguarding the quality of surface waters. Registration is mandatory for all feedlots of 300 or more head. (Exhibit 28) These lots must be in compliance with state and federal regulations administered by the State Department of Health and Environment. Approximately 80 percent of the feedlots having 300 or more head have been appraised for pollution control requirements with about 90 percent of the combined feeding capacity presently meeting the requirements. All feedlots are scheduled to be in compliance with state and federal regulations by 1976.

Other agricultural wastes production in the unit comes from: runoff including agricultural chemicals such as fertilizer, pesticides, and herbicides; sediment from soil erosion; and from irrigation return flows. The addition of nutrients from farm fertilizers into streams and ponds can cause algal blooms with resultant scum, undesirable tastes and odors, and a reduced dissolved oxygen content. Soil erosion produces turbidity in most of the streams and ponds. It reduces the life of ponds and reservoirs and adversely affects the quality of the fisheries.

The return flows from irrigation are always higher in dissolved minerals than the water which was applied to the field. They may also carry considerable amounts of pesticides, herbicides, and fertilizers. Irrigation return flows do not appear to pose a serious threat to water quality in this unit except possibly on the mainstem of the Arkansas River. In most cases on the upland areas very little runoff from irrigation reaches the water courses and with the increasing

use of tail-water ponds and recirculating systems, irrigation return flows are not expected to be a problem.

Phreatophytes

The floodplain vegetation of the Great Plains is becoming increasingly important in relation to water salvage and flood control. This floodplain growth is termed phreatophyte vegetation and it exists because of an abundant supply of subsurface water. Phreatophytes occur where the water table lies at a shallow depth within reach of their roots. They are most conspicuous as dense growths lining the banks of streams, on floodplains, on the deltas of reservoirs, around the edges of perennial lakes, and along irrigation canals.

In 1967 there were some 22,842 acres with a cover of woody phreatophytes along the Arkansas River between the Kansas-Colorado state line and Great Bend or an average of 93.37 acres per mile. There are three predominant types of phreatophytes along this 250 miles of the Arkansas River valley in eight western Kansas counties. These are salt cedar (Tamarix ramosissima), cottonwood (Populus sargentii), and willows (Salix spp.). (Exhibit 33) In the western counties, salt cedar is dominant while cottonwood becomes increasing important eastward. Willow is less abundant, but quite consistent throughout the entire area. In general, there are no abrupt breaks or changes in species composition of the woody phreatophytes along the 250 miles of floodplain.

The occurrence of other woody species is negligible except near Great Bend where nine other species are observed. They include: Russian olive (Elaeagnus angustifolia), skunk-bush (Rhus trilobata), false indigobush (Amorpha frutcosa), hackberry (Celtis occidentalis), osage orange (Mcclura pomifera), boxelder (Acer negundo), dogwood, mulberry, American elm, and green ash.

Herbaceous vegetation occurs both under the woody species and in the unshaded areas between them. The more dominant grasses along the Arkansas River floodplain are salt grass (Distichlis stricta) and alkali sacaton (Sporobolus airoides). Near Great Bend Mulenbergia spp. become quite noticeable. Russian thistle (Salsola pestifer) and Kochia (Kochia scoparia) are the most common weed species to be found.

SALT CEDAR, WILLOW, AND COTTONWOOD TREES GROW ALONG THE ARKANSAS RIVER IN EDWARDS COUNTY.
Photo by: U.S. Forest Service

The problem created by phreatophytes in relation to streams is twofold. They tap the groundwater and cause considerable water loss through transpiration. Per unit area, tamarisk uses more water than any other phreatophyte and because of its aggressive nature, it soon dominates most areas. Also, some phreatophytes growing in channels present a partial barrier during floods. By interfering with the flow of water they cause deposition of sediments, raise the level of the stream channels, and reduce the floodwater carrying capacity.

It is desirable to control phreatophytes for the purpose of using the salvaged water for more beneficial purposes. There are no widespread programs in progress for their control. Some individual landowners are clearing willows and salt cedar for the purpose of developing hay or pastureland. No inexpensive method has been found to control the large tamarisk plants growing in their dense stands. Because of this, it has been necessary in some areas to mechanically remove the adult plants and do the necessary followup job of controlling seedlings and regrowth. Burning

of willows and salt cedar has been tried along the Arkansas valley with very little permanent benefit. Both grazing and cultivation have had a definite restrictive influence on the spread of phreatophytes along the valley, however, cultivation is more restrictive than grazing. The treatment of the infested areas is worthy of consideration in water planning programs.

Range and Forest Fires

Following are the number of fires and acres burned by major cause for the five-year period 1963-1967 for protected state and private land in the Upper Arkansas Unit:

Item	Year 1963	1964	1965	1966	1967	5-yr. Ave.
No. of lightning-caused fires	0	2	4	0	5	2
No. of man-caused fires	1	25	35	102	109	54
Area burned 1/ - acres	84	2,021	916	8,923	12,628	4,914

1/ Includes organized rural fire districts only

A general discussion of the basin-wide range and forest fire problem is included in the Walnut-Verdigris Unit narrative beginning on page 199.

Impairment of Natural Beauty

Drought is probably the most noticeable cause of the impairment of natural beauty in this unit. Vegetation, especially in upland areas, readily shows the effects of insufficient moisture. Non-irrigated crops wither. Hot, southerly winds increase evaporation and add to the problem. Fields of potentially lush green milo with contrasting deep red heads of grain are instead browned and headless. The winds are quick to move the soil when protective vegetation is reduced. Blowing dust darkens the sky and covers everything with a layer of gray.

Occasional flooding which carries sediment and debris and erodes irrigated land is another problem reducing the natural beauty of the environment.

UPPER ARKANSAS UNIT

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Land Treatment

The Soil Conservation Act of 1935 (P.L. 74-46) authorizes the Soil Conservation Service to provide a broad program of soil and water conservation operations. The program includes direct assistance to landowners and operators and technical services to other agencies and organizations.

The Kansas Soil Conservation Districts Law was enacted into law in April of 1937. The law provided that each county would be designated as a soil conservation district. The first district in the state was organized in June of 1938 and the entire state was covered by March of 1954. In the Upper Arkansas Unit, the first district was organized in Pawnee County in January 1940 and the last in Hodgeman County in May 1949.

The soil conservation districts have accepted the responsibility of working toward solution of the conservation problems within their respective areas. Assistance is provided by the Soil Conservation Service, Agricultural Stabilization and Conservation Service, Forest Service, and the Extension Service. Federal cost sharing is made available through the Rural Environmental Assistance Program and the Great Plains Conservation Program. To date, 30 percent of the total cropland acres and 40 percent of the total rangeland acres have been adequately treated.

Upstream Watershed Projects

The Watershed Protection and Flood Prevention Act, Public Law 566, as amended, provides for projects which may include watershed protection, flood prevention, agricultural water management, municipal and industrial water supply, recreation or fish and wildlife development, and pollution abatement.

Two watershed work plans have been completed and approved for installation.* (Exhibits 34 and 35) The installation of

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* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

land treatment and structural measures has been completed on both Cimarron and Lakin Watersheds (CNI Nos. 1-77 and 1-68). These two projects have a total area of 17,246 acres. The works of improvement provide watershed protection and flood prevention. Structural measures include eight floodwater retarding structures, two grade stabilization structures, and 5.4 miles of floodways. The floodwater retarding structures have a total storage capacity of 3,619 acre feet. With planned land treatment and structural systems installed, total average annual direct damages will be reduced by about 98 percent. About 2,400 acres of agricultural land and the cities of Cimarron and Lakin (combined population 2,809) are benefited.

FLOODWATER RETARDING DAM IN CIMARRON WATERSHED, GRAY COUNTY.

Planning has been suspended on one watershed approved for planning (Cheyenne Creek). Planning assistance has been authorized for five watersheds (the Wet Walnuts) covering a total area of 1,020,520 acres. Applications for planning assistance have been received and priorities of planning have been assigned for seven additional watersheds (the Pawnees). The Pawnees have a total area of 1,583,237 acres.

Since proper land treatment, the basic element of watershed projects, is so closely interrelated with structural measures, P.L. 566 requires at least 50 percent of the land above watershed structures must be under cooperative

agreement to carry out recommended soil conservation measures prior to construction. In addition at least 75 percent of the effective land treatment measures must be installed, or their installation provided for, on critical sediment source areas above structures.

Resource Conservation and Development Projects

The general discussion of program provisions beginning on page 148 also applies to the RC&D program in this unit. A portion of the Sunflower Project is included in this unit. See pages 13-14 for current RC&D status and basin area involved.

Flood Control Projects

The Corps of Engineers, Albuquerque District, has planned local protection projects for two cities on the Arkansas River in this unit. (Exhibit 34) Both projects have been authorized for construction. The $3.7 million Dodge City project is currently in the detailed planning stage. This project will consist of levees, flood walls, and channel and bridge improvements. The $5.8 million Great Bend project is to consist of levees, channelization, and diversions on the Arkansas River and Wet and Dry Walnut Creeks. Pre-construction planning has been suspended pending resolution of opposition from local interests.

Irrigation

Irrigation development in the Upper Arkansas Unit dates back to the early 1880's when several irrigation canals or "ditches" were constructed to convey surface water diverted from the Arkansas River. Additional canals were planned for the irrigation of several hundred thousand more acres but were never developed. Extensive upstream surface water use for irrigation in Colorado utilized Arkansas River flow to the point where flow in this unit was inadequate for expanded development. Eight ditches and canals remain in use at the present time. Lake McKinney, near Lakin, is used as a storage reservoir in conjunction with the Amazon Ditch. About 50,000 acres are irrigated from surface water sources, 90 percent of which is in Kearny and Finney Counties.

Irrigation from groundwater has steadily increased since successful installation of a deep well, turbine type, centrifugal pump in Scott County in 1910. In 1959 an estimated

305,000 acres were irrigated in this unit. A current estimate puts the irrigated acreage at 670,000 acres compared to the state total of 1,700,000 acres. Groundwater is the source for 1,510,000 acre feet of water used annually and surface water is the source for 120,000 acre feet. (Exhibits 19, 20, 21, and 22)

Drainage

Five drainage districts were organized in the late 40's and early 50's in this unit. Finney County districts and their area are: Finney County No. 1 - 6,600 acres; Finney County No. 2 - 12,800 acres. Ford County districts and sizes are: Lewis Addition - 120 acres; Park Street - 480 acres; Wilroad Gardens - 950 acres. All districts are active except Finney County No. 1.

Water Supplies for Rural Domestic and Livestock Uses

The rural water district program has not yet been utilized for solving water supply problems in this unit. Studies concerning application of this program are currently underway in parts of the unit.

Municipal and Industrial Water Use

There are no communities or industries in the unit which rely on surface water supplies with the possible exception of sand and gravel operations. (Exhibit 27)

Recreation

The Land and Water Conservation Fund Act (P.L. 88-578) became effective on January 1, 1965. The purpose of this Act is to provide for proper preservation and development of public outdoor recreation areas and facilities. This will be done by: (1) providing funds for and authorizing federal assistance to the states in planning, acquisition, and development of needed land and water areas and facilities; and (2) providing funds for the federal acquisition and development of certain lands and other areas.

Principal lakes in the unit are State Forestry, Fish and Game Commission state lakes in Hodgeman, Finney, and Hamilton Counties; Ford County Lake, Hodgeman County Lake; Rush County Lake; Hains Lake; and Lake McKinney, a privately-owned

irrigation reservoir leased by the State Forestry, Fish and Game Commission for recreational purposes. (Exhibit 8) Drainage and surface areas of the lakes are:

Name	Drainage Area (sq.mi.)	Surface Area (acres)
Hodgeman County State Lake	13.4	87
Finney County State Lake	15.1	324
Hamilton County State Lake	20.6	94
Ford County Lake	13.2 1/	65
Hodgeman County Lake	173.6 1/	33
Rush County Lake	5.84 1/	16
Hains Lake	8.4	53
Lake McKinney	242.0 2/	1,700 3/
Lane County State Lake	?	21
Scott County Lake	?	115

1/ Measured from county highway maps (scale 1/2" = 1 mile)

2/ CNI drainage area from Mattox Draw. Does not consider water diverted from Arkansas River via Amazon Ditch

3/ Measured from U.S.G.S. 7 1/2 minute quads

<u>Fish and Wildlife</u>

Forestry, Fish and Game Commission biologists conduct surveys and evaluate fish and wildlife within the unit on an annual basis. Fish stocking and rehabilitation programs are initiated when needed and when funds are available.

The Forestry, Fish and Game Commission restocked prong-horn antelope in Edwards County in 1965 and 1967. (Exhibit 10) These animals were from the Sioux Army Depot in Nebraska and were found to be only semi-wild. Consequently, they have not successfully maintained their numbers. The Commission has recently transplanted wild Rio Grande turkeys in the unit with apparent success.

In addition to projects concerning individual species the Forestry, Fish and Game Commission has designated five areas (Hodgeman County State Lake, Lake McKinney, Finney County State Lake, Hamilton County State Lake, and Hains Lake) as public hunting areas. (Exhibit 8) These five areas contain approximately 4,600 acres of state-owned or

leased lands. Lack of manpower and equipment prevents large scale programs for habitat development at these areas.

Cooperative State-Federal Forestry Programs

The Walnut-Verdigris Unit includes discussion of cooperative state-federal forestry programs beginning on page 212.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Land Use and Conservation Treatment

Land treatment measures have been installed on 30 percent of the cropland area. Residue management, stripcropping, and terracing are the major conservation needs for the dryland farming area. The most needed treatment on irrigated land is planned irrigation systems to efficiently convey and apply water without excessive erosion or water losses. Permanent cover should be established on approximately 46,200 acres. Forty percent of the rangeland has received adequate conservation treatment. The principal measures needed to complete treatment of the rangeland are proper grazing use, range seeding, and brush control.

A large part of the unit's woodlands are on sites capable of excellent timber growth--over two-thirds are rich bottom land and side drainage sites. However, only one acre out of three is adequately stocked at present.

It is reasonable to project that about 65 percent of the cropland treatment needs and about 74 percent of the rangeland treatment needs can be accomplished by the year 2000. Projections assume continuation of current incentive programs and are based upon established trends.

Upstream Impoundment Sites

Floodwater retarding structure sites are generally available where needed for reduction of flood flows. It is usually desirable to locate sites as close as possible to primary damage areas for maximum damage reductions. This goal is attainable in most watersheds of the unit. Development in a few will be limited by lack of physical sites. (Exhibit 36)

Average drainage area size of physical sites increases generally from east to west across the unit. Physical sites are not available until large drainage areas are reached on watersheds with headwaters in the nearly flat tableland areas

of LRA 72. One example is the upper mainstem of James Draw (Greeley, Hamilton, Wichita, Kearny, and Finney Counties). Topography sufficient to contain needed storage is not found until a point where nearly 100 square miles of drainage area is reached.

Three hundred and twenty-eight sites were examined during this investigation. Drainage area sizes ranged from 1 to 284 square miles. Total drainage area controlled (area from which runoff water must pass through reservoirs before proceeding downstream) by sites investigated is 5,127.5 square miles or 49.6 percent of the unit area. Some sites are in series. Sites were not investigated on the Arkansas River mainstem. Many of the sites studied are in pasture or involve only the poorer dryland cropland. Relocation of roads, farmsteads, and pipelines will be necessary for development of some sites. Site characteristics range from poor to excellent. Some will require long, low dams and will have reservoirs of large surface area. Sites typical of this group are found in Whitewoman Creek Watershed. Sites with deep storage and moderately high dams are plentiful in the Pawnee River Watersheds.

Economic factors will limit development of floodwater retarding structure systems in most watersheds in the unit. Damage rates are generally low because of infrequent flooding. A few watersheds with high producing irrigated floodplains have high damage rates in spite of infrequent flooding. Economic conditions will not support development of the full physical flood control potential in most watersheds. The net effect of economic factors in watersheds, where development is both physically and economically feasible, will be to restrict structures to those having large drainage area size.

Channel Work

Streams in the unit generally have sufficient channel capacity to preclude channel improvement as a practical method of flood control. Channel improvement will probably be necessary as a measure in addition to land treatment and floodwater retarding structures in three watersheds. In these three, channels are either nonexistent or too small to carry structure release and uncontrolled flows from more frequently occurring storms.

Agricultural Water Management

Storage - Surface water storage for irrigation use is not efficient in this unit except in sites where storage would be deep in relation to surface area. (Exhibit 37) Shallow reservoirs with large surface areas expose too much area to high evaporation and seepage rates. Low water yield in relation to loss and use requires abnormally high carry-over storages in order to provide needed water over multi-annual drought periods. In most cases stream yields are not enough to take advantage of the physical storage available. Irrigation storage may be physically feasible by selection of sites with large drainage areas and deep storage but the cost would be high in relation to the potentially irrigable area.

The problems encountered with surface irrigation water storage also apply to storage for rural domestic and livestock use. Demand would ordinarily be less and therefore physical feasibility would be somewhat better. Generally groundwater is a more economical and reliable water source for rural domestic and livestock needs than surface water. In areas where groundwater is not adequate, needs could be met by deep reservoirs with large drainage areas. Several users may be forced to obtain their water from the same reservoir in order to divide the cost. Distribution costs would be high for the more remote users.

Groundwater recharge by reservoir storage appears to be, at least theoretically, feasible. Surface storage for other uses becomes beneficial for recharge. Storage on permeable soils, even temporary as in a detention pool, will increase recharge by seepage provided subsurface strata will allow the water to reach the underground reservoir. Reservoir release at proper rates to take advantage of channel infiltration will also increase recharge quantities under proper subsurface conditions. Recharge studies in this unit are underway by the Kansas Water Resources Board and U.S. Geological Survey. Results of these studies will do much to determine the feasibility of recharge.

Drainage - Tailwater and storm runoff problems presented by irrigation development of the nearly flat, pot hole marked, tablelands can often be solved by making use of natural storage

provided by the pot holes. Deepening of one or more pot holes into tailwater recovery pits may be necessary. Extra storage can be provided for storm runoff. Storm runoff should be diverted from the pits where possible. Pits may be pumped to make more efficient use of water and to provide storm runoff storage. This method is applicable to both flood and sprinkler systems. This approach can also be expanded to provide excess water disposal areas for several farms in a coordinated community plan. Large pits or ponds also provide recreation opportunities. It is reasonable to assume that most of the remaining drainage problems can be solved by individual on-farm action by the year 2000.

THIS TAILWATER RECOVERY PIT IN FINNEY COUNTY COLLECTS RAINFALL AND EXCESS IRRIGATION WATER FROM A 600-ACRE AREA.

Non-Agricultural Water Management

Opportunities for development of multiple-purpose structures including municipal-industrial water supply are limited. The number of sites close enough to cities or industries to keep transmission costs reasonable and that have potential

to provide the supply needed through a two percent chance drought are much more limited than the number of sites with the potential to serve agricultural needs. Low yield and high evaporation and seepage rates force selection of sites with large drainage areas and deep storage in order to assure supply. Physical opportunities do exist for development of reservoirs on large drainage areas for water supply to small cities. The cost would be high in relation to the number of people being served. The cost per user could be improved by tying several cities and intervening rural users to one large reservoir.

Broader opportunities exist for development of multiple-purpose reservoirs including recreation and/or fish and wildlife storage. Demands for these purposes are such that failure of the supply can be tolerated more frequently than most other uses. Many of the reservoirs studied have some degree of potential for recreation or fish and wildlife development. Sites with large drainage areas and deep storage are still the most desirable. (Exhibit 37)

Water Quality Control - Watershed planning should include the possible improvement of the quality of downstream flows by water quality storage. The storage could be used to enhance low flows by releasing good quality water to dilute inorganic pollution from natural sources, industrial sources, or irrigation return flows, or to dilute organic pollution from feedlot runoff, municipal and industrial wastes, and runoff from agricultural fields. Storage could also be used to impound poor quality water to reduce organic pollution by retention for several days with resulting bacterial decay, or to retain water with excessive dissolved salts for later release during periods of high flow.

The storage requirements for dilution purposes may need to be quite large. For example, if the chloride concentration in a stream were 500 mg/l with an average streamflow of 5 cfs, and it was desired to reduce this to 250 mg/l, then a water flow of 5 cfs having zero chlorides would have to be added. Five cfs flowing constantly for a year would be a volume of 3,600 acre feet of water and generally several times this amount would have to be stored in order to be assured of having it during droughts. On the other hand, the requirements to reduce organic pollution below a small town could be considerably less.

The present federal policies toward financing storage for water quality control purposes under the watershed program are very restrictive. In contrast to financing policies set forth under provisions of the Federal Water Pollution Control Act which provides for federal financing of water quality control storage, the interpretation under P.L. 566 provides that all storage for water quality control must be completely financed by local entities. There is a great need for the development of uniform financing policies for all federal agencies dealing with water resources projects. Where watershed structures and larger projects are being planned for the same area, the possibility of complementary storage should be explored.

Availability of Land and Water for Potential Development

Eighty-one reservoir sites were recognized as having limited multiple-purpose development potential in this unit. However, the yield into these sites will seldom be adequate to maintain the water level much above the 100-year sediment storage pool.

Cropland would be involved in development of the full storage potential of most sites. A large part of the cropland would be non-irrigated. All of the land is in private ownership except for that involved in roads or highways. The possibilities of encroachment on roads, farmsteads, or pipelines increase as storage is increased in most sites. Railroads or highways would be involved in a few cases. No towns would be affected by any of these sites. Other larger sites not investigated are likely to involve more serious encroachment on physical improvements.

UPPER ARKANSAS UNIT

OPPORTUNITIES FOR DEVELOPMENT WITH USDA PROGRAMS

Land Treatment Measures

The policy for determining land treatment priorities rests with the soil conservation districts. It is the district supervisors' responsibility to indicate which programs, practices, and individuals have top priority in their district. The major programs affecting the installation of land treatment measures in the Upper Arkansas Unit include the Rural Environmental Assistance Program and the Great Plains Conservation Program.

The Rural Environmental Assistance Program is administered by the Agricultural Stabilization and Conservation Service through an elected county committee. The soil conservation district participates with the county ASC committee in developing agricultural conservation programs for their district. This program offers cost sharing for the installation of certain land treatment measures. The Soil Conservation Service provides technical assistance for the application of the land treatment measures.

The Great Plains Conservation Program is administered by the Soil Conservation Service. The program helps individual farmers and ranchers carry out a plan of operations that will help minimize climatic hazards and protect the land from erosion and deterioration by natural causes. The participant enters into a three to ten year contract with the Secretary of Agriculture. The program guarantees federal cost-sharing for applying needed land treatment measures. To participate in the program the individual must have a workable plan of operations that incorporates needed land use changes, needed cropping and grazing systems, and needed soil and water conservation practices in proper combinations.

The Extension Service assists the soil conservation districts with the educational phases of land treatment programs through preparation and publication of general information.

The Farmers Home Administration will make loans to individuals for financial help in applying land treatment measures.

The total cost of installing the needed land treatment measures listed in Exhibit 17 for the Upper Arkansas Unit is estimated at $120,100,000.

Upstream Watershed Projects

The Watershed Protection and Flood Prevention Program (with authority provided by Public Law 566) is carried out jointly by local, state, and federal agencies with the full understanding and support of a majority of the landowners and citizens of the community. The federal government will pay all construction and installation service costs allocated to flood prevention and share up to 50 percent of construction cost of agricultural water management, recreation, and fish and wildlife developments.

Complete land treatment is an essential part of floodwater and erosion control in this area. The most effective measures for cropland are terracing and residue management. The kind of educational program and organization provided through soil conservation and watershed districts working with well-developed work plans will help to establish the degree of land treatment needed.

It is generally not possible to properly involve local people in basin watershed investigation studies because of their preliminary nature. In order not to preclude local desires or ideas, this report will not present any specific system of structural control.

Early Action Projects - Eight upstream watersheds within the Upper Arkansas Unit were found to be feasible and needed within the next 10-15 years. Three of these exceed the 250,000 acre limitation of P.L. 566 and must be subdivided into the proper number of watershed applications to comply with the law. The total number of watersheds estimated to be feasible is seventeen. (Exhibit 38)

Watershed	CNI Number	Drainage Area Acres	Number of P.L. 566 Size Watersheds Included
Ash Creek	1-89	88,274	1
Coon Creek	1-87	253,898	1
Dry Walnut	1k-6	104,857	1
James Draw	1-65	240,274	1
Pawnee River	1j(1-6) & 1j1(2-3)	1,739,046	8 3/
Sand Draw	1-85	11,838	1
Syracuse Creek	1-61	54,900	1
Whitewoman Creek 1/	1i(2-4)	793,328	3
Total		3,286,415 2/	17

1/ Kansas and Colorado
2/ 256,570 acres are in Colorado
3/ Covered by 7 applications

The seventeen watersheds include an area of more than 3 million acres in Kansas or 50 percent of the Upper Arkansas Unit. Seven applications for watersheds of the Pawnee River have been received and planning priorities assigned. James Draw is in the pre-application stage of development.

It would be possible to economically control about 2,254 square miles or 44 percent of the area included in the 17 feasible watersheds. These figures are based on an estimate of the physical, economic, and social aspects of each watershed. Local interests may have valid reasons for variation from systems selected for this study. Any variation from the systems for which data is summarized in this report would produce different physical and economic values.

The 2,254 square miles of control can be accomplished with 73 reservoirs. (Exhibit 39) It is estimated that 58 of these sites will be single purpose floodwater retarding structures and 15 will be multiple-purpose floodwater retarding and recreation structures. Total storage capacity of the 73 structures will include: sediment, 38,910 acre feet; detention, 275,650 acre feet; and recreation, 4,523

acre feet. Surface area totals are: sediment pools of single purpose floodwater retarding structures, 3,650 acres; permanent pools of multiple-purpose floodwater retarding and recreation structures, 2,203 acres; detention pools (all structures), 22,894 acres.

A total of 40 miles of channel improvement and/or new channel is considered necessary in two watersheds in order to increase the level of protection. The twelve miles included in Ash Creek would consist primarily of alignment changes. James Draw was considered to need 28 miles of new channel to carry structure release across irrigated lands to one of the large pot holes of the Scott-Finney depression. Defined stream channels do not exist in this area. New channels would be constructed in cropland and along road ditches and seeded to appropriate grasses resulting in new environmental corridors for wildlife. Other alternatives exist for channel improvement location and design. Specific information must await more detailed study.

Long Range Projects - There are two additional watersheds that merit future consideration for project development. At present these projects are not economically feasible because of high interest rates, high costs, and evaluation procedures. They should be re-evaluated if any favorable changes occur in evaluation factors. This group of projects includes 128.76 square miles, 67 percent of which could be controlled by three structures. Total storage capacity would probably include: sediment, 1,253 acre feet, detention, 9,023 acre feet; and recreation, 566 acre feet. Surface area totals are: sediment pools of floodwater retarding structures, 215 acres; permanent pools of multiple-purpose structures including recreation storage, 215 acres; detention pools (all structures), 822 acres.

Cooperative State-Federal Forestry Programs

Forest land treatment measures are needed to supply quality timber for present and future generations. The land treatment measures will be maintained by landowners and operators. The following table lists estimated land treatment measures proposed on State and private forest lands in the Upper Arkansas Unit to 1980 (estimated cost - $610,600):

Item	Unit	Amount
Timber surveys	Acres	9,000
Forest management (technical assistance) timber thinning, pruning, and releasing	Acres	5,000
Growing and distribution of seedling trees for reforestation and wind barriers	Trees	5,000,000
Tree planting and seeding	Acres	7,500
Insect and disease control program	Acres	5,000
Fire control programs	Acres Miles	3,700 1,500
Cooperative watershed protection and flood prevention	Acres	17,000

Resource Conservation and Development Projects

A portion of the authorized Sunflower Resource Conservation and Development Project is included in this unit. Opportunities for development within this project are discussed in the Lower Arkansas Unit narrative beginning on page 163.

Rural Water Districts

There is little need for rural water districts in this unit. Generally, there is sufficient groundwater of good quality to meet municipal, rural domestic, and livestock demands. (Exhibits 22 and 27)

Rural Electrification Administration

The Rural Electrification Administration makes loans to qualified borrowers, particularly cooperatives and public bodies, to finance construction of electric facilities to provide initial and continued adequate electric service to persons in rural areas. It provides borrowers technical assistance in accounting, engineering, and management improvement where needed. Rural Electrification Administration also assists its borrowers in rural areas development programs.

IMPACT OF USDA PROGRAMS

Land Treatment Measures

The economy of the Upper Arkansas Unit is dependent on agriculture. Application of the needed land treatment measures listed in Exhibit 17 will increase crop and livestock production and have a direct effect on the economy.

Land treatment measures such as residue management, stripcropping, and terracing will reduce erosion and sediment yield and allow better use of precipitation. Planned irrigation systems and irrigation water management will conserve and result in more efficient use of underground water resources. Proper grazing use, brush control, and range seeding will increase forage production resulting in increased livestock production and improve the natural beauty of the grazing lands.

Land treatment benefits in this unit, from flood reduction in planned watershed projects and those authorized for planning or recommended as early action projects, are nearly $250,000 annually.

Upstream Watershed Projects

Watershed projects are a major effort in man's battle to stop environmental degradation. Flood protection is provided for valuable agricultural land and wildlife habitat. Reduction in depth and frequency of flooding will: reduce agricultural losses; allow more efficient use of floodplain land; reduce losses to roads, bridges, urban areas, mineral facilities, and other non-agricultural installations; reduce the spread of weed seed and enhance the maintenance of desirable land cover; and decrease sediment pollution of streams and reservoirs.

Streams below watershed dams will have longer periods of flow sufficient to provide flushing action. Turbidity and the occurrence of stagnation will be reduced. Fishing will improve in some of these streams. Hunting opportunities will increase because of reduced flooding and availability of new water areas.

More widespread recreation opportunities, both planned and incidental, will be available. Fishing, boating, camping, hunting, and picnicking opportunities will be increased.

Groundwater recharge incidental to floodwater storage in reservoirs on permeable soils will occur. A net increase in recharge rates may also occur from reservoir release at proper rates to take advantage of channel infiltration. Studies sufficient to provide an estimate of groundwater recharge benefits were carried out only for the Wet Walnut Watershed. Further studies of quantities and benefits should be a part of work plan evaluations.

Existing Projects - Floodwater and sediment damages will be reduced to a varying degree for 38,968 acres of floodplain upon completion of the seven existing projects. (Exhibit 18) Existing projects include those having attained the status of planning authorization or beyond. Average annual damages will be reduced some 71 percent by these projects. (Exhibit 40) Total expected benefits are as follows:

Flood Damage Reduction	$ 94,100
Recreation (as a purpose)	$ 75,900
Land Enhancement	$ 22,000
Off-Project	$544,900 1/
Other	$ 62,900
Local Secondary	$ 83,000
Total	$882,800

1/ Includes $246,860 damage reduction benefits

Average annual cost of structural measures included in existing projects totals $537,000. Comparing total benefits to total costs produces an overall ratio of 1.6:1 for these seven projects.

Early Action Projects - Installation of works of improvement under P.L. 566, in the 17 feasible early action projects will directly benefit 199,026 acres of floodplain lands within the watershed areas. (Exhibit 18) In addition, the works of improvement will provide benefits to downstream floodplain, outside the watershed boundaries.

It is estimated that average annual flood damages can be reduced 53 percent through installation of land treatment and structural measures in the 17 watersheds. This reduction can be accomplished with a physically and economically feasible system in each watershed. Economic effects of one such possible system for each watershed are summarized in this report. (Exhibit 41)

Average annual benefits for structural measures in the 17 watersheds are: flood damage reduction, $611,800; recreation (incidental and as a purpose), $176,300; land enhancement, $134,300; off project, $287,100; other $11,600; and local secondary, $112,800, for a total of $1,333,900.

Average annual cost of structural measures to be installed in early action projects is $1,034,300. The ratio of total benefits to total costs for these 17 projects is 1.3:1.

Recreation benefits evaluated were primarily for those structures for which estimated costs include storage for recreation use. Fifteen of the reservoirs fall into this category. Combined surface area of recreation pools is estimated to be 4,523 acres.

Long Range Projects - Two additional watershed projects including 128.76 square miles may someday become economically feasible. These projects would benefit 1,519 acres of floodplain land. Total average annual benefit and cost figures for these projects are:

Benefits	$31,500
Costs	$46,700
Benefit-Cost Ratio	0.7:1

Forest and Grassland Management Programs

The general discussion beginning on page 228 also applies to the impact of forest and grassland management programs in this unit.

Estimated employment in the unit in timber-based industries is expected to rise from zero employees in 1964 to about 145 in 2020. (Exhibit 42) These estimates are based upon anticipated timber cut. One hundred and thirty-five people will be used in the manufacturing of primary timber products.

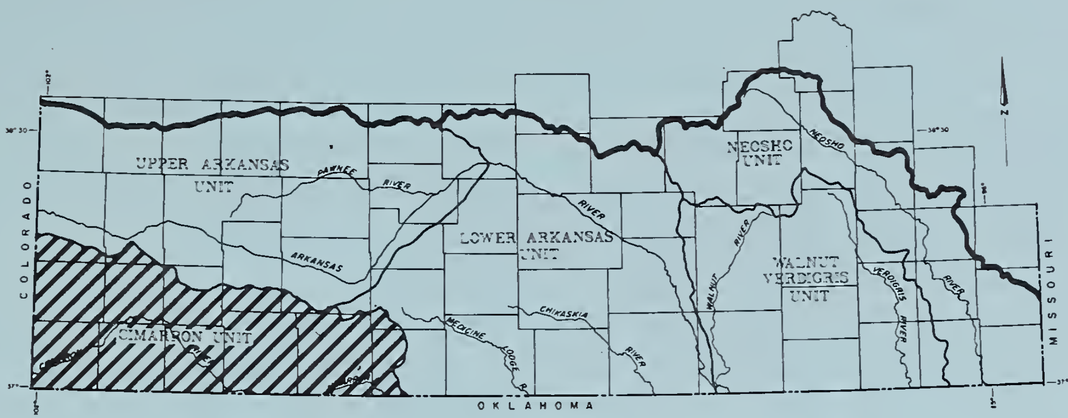
Resource Conservation and Development Projects

Impacts of the authorized Sunflower RC&D project are discussed in the Lower Arkansas Unit narrative on page 169.

Rural Water Districts

The impact of rural water districts in this unit will be small. It is anticipated that very few districts will be developed.

CIMARRON UNIT



Land Use - Cropland - 2,886,710 acres
Rangeland - 1,188,400 acres
Forest - 6,380 acres
Other - 262,810 acres

Total Area - 4,344,300 acres

Total Capability Class II, III, and IV Land - 3,362,950 acres (77%)

Irrigated Acreage - 560,000 acres (1971)

Average Annual Precipitation - 15 to 21 inches

Land treatment is adequate on 579,300 acres of cropland (20%) and 451,900 acres of rangeland (38%)

The total cost of applying needed crop and pasture land treatment is estimated to be $86,300,000

The total cost of applying needed forest land treatment is estimated to be $581,400

Floodwater and sediment damages on tributary streams average $679,400 annually--some 68,400 acres are subject to inundation

P.L. 566 Watershed Projects Completed or Authorized for Construction - None

The Cimarron National Grassland contains 107,000 acres

There are no Early Action watershed projects recommended

Bear Creek subbasin merits consideration for Long Range project development

CIMARRON UNIT

NATURAL RESOURCES

Location and Size

The Cimarron Unit is an elongated area of 4,344,312 acres (6,788 square miles) in the extreme southwestern corner of the state. This unit includes about 16 percent of the Arkansas River Basin in Kansas. The western boundary coincides with the Colorado-Kansas border and is about 74 miles long. One hundred seventy miles to the east, the eastern border extends north-south about 40 miles.

The Cimarron River enters Kansas from Colorado in Morton County. In Kansas the river flows in a northeast direction to the southern portions of Grant and Haskell Counties and then turns to the southeast. After leaving the state in Meade County, the river re-enters 30 miles east in Clark County and then leaves the state for the last time 24 miles east in Comanche County. Principal tributaries of the Cimarron River in Kansas are the North Fork Cimarron, Crooked Creek, and on occasions of high runoff, Bear Creek. Drainage areas by major stream are:

Name	Area in Square Miles
Cimarron River 1/	3,943
North Fork Cimarron River	961
Bear Creek	779
Crooked Creek	1,044
North Canadian River	61
	6,788

1/ Includes Bluff and Big Sandy Creeks

Counties entirely within the Cimarron Unit are Stanton, Morton, Grant, Stevens, Seward, and Meade. Other counties partly included are Hamilton, Kearny, Haskell, Gray, Ford, Clark, Kiowa, and Comanche. (Exhibit 1)

Climate

Most of the Cimarron Unit has a semiarid, continental climate that results from being in the rain shadow of the

Rocky Mountains. Because there are no effective barriers north or south of the unit, the wind sweeps from those directions and causes wide seasonal changes of temperature that are sometimes sudden. Daily ranges in temperature are also high because most days are sunny.

Average yearly precipitation ranges from 15.08 inches at Johnson to 21.38 inches at Ashland. (Exhibit 2) Precipitation varies widely from year to year and is generally inadequate for optimum growth of most crops. The kinds of non-irrigated crops that can be grown successfully are limited because average evapotranspiration is considerably higher than average precipitation. Normally, three-fourths of the annual precipitation falls during the six month period from April through September. Monthly rainfall amounts fall off rapidly in August and September. Occasionally soil moisture is inadequate for planting of winter wheat and other fall-sown crops.

Much of the rainfall in the unit comes as showers and thunderstorms. On the average, an inch of rainfall in less than a one hour period can be expected each year. Once in 100 years six inches can be expected in 24 hours at any point within the unit. On the average, 50 to 60 days each year have thunderstorms, a few accompanied by high winds and hail. Hail damage is usually confined to small local areas.

Snowfall is not of great consequence in the unit. The average for central areas is about 15 inches annually. Because the snow often drifts, much moisture and protective cover are lost. The ground seldom remains covered long because the abundant sunshine melts the snow.

Droughts are often severe and occasionally several successive years are drier than normal. Droughts were especially severe during the period 1931 through 1935 and 1952 through 1956. In addition to the hazard of drought, hot, burning winds affect the area.

Average annual lake evaporation ranges from 60-63 inches in this unit. Two years out of 100, annual lake evaporation will exceed average evaporation by 25-30 percent.

Records kept for the weather station at Liberal in Seward County indicate average January and July temperatures

of about 35 and 82 degrees respectively. Extremes in temperature range from 113 degrees, recorded June 30 and July 1, 1933, to -19 degrees recorded January 7, 1912. Records for other weather stations in the unit show similar temperature patterns. The average length of frost-free period ranges from 170 days in Stanton County to 190 days in Comanche County. Freezing temperatures at Liberal were recorded as late as May 27 and as early as September 20.

The wind is almost always noticeable to a newcomer in this area. Records kept at Liberal show the highest average wind speed to be 17 miles per hour in March and April. The lowest average speed, 13 or 14 miles per hour, is in July and August. The unit is susceptible to damaging wind gusts, tornadoes, and dust storms. Occasionally when winds shift or thunderstorms occur early in spring or in summer, damaging gusts reach a speed of 70 or 80 miles per hour. Tornadoes do not occur frequently and loss of life or property is usually not great when they do because the population is scattered.

Topography, Geology, and Soils

The Cimarron Unit is in the Red Hills and the High Plains section of the Great Plains physiographic province. The surface features that make up the physiographic divisions are directly related to the surface geology.

The principal physiographic division in the unit is the High Plains. It covers all of the area except southeast Meade County and most of Clark and Comanche Counties. Pleistocene deposits composed of silt, clay, sand, and gravel of loess and fluvial origin cover the relatively level plains up to 500 feet in depth. Sand dunes of Recent Age are scattered over Morton, Stevens, and Seward Counties. Numerous pot holes appear on the broad divides. Isolated outliers of chalk, sandstone, and shale of older formations are exposed in western Stanton and Morton Counties.

East of central Meade County the Pleistocene mantle thins and the High Plains gives way to the more rugged topography of the Red Hills with exposed Permian Red Beds. The Red Beds are sandstone, siltstone, and shale containing salt, gypsum, and dolomite.

ROUGH RANGELAND IN THE RED HILLS OF CLARK COUNTY.

The highest point, 3,720 feet above sea level, is near the Colorado state line in Hamilton County. The lowest point, approximately 1,680 feet, is on the Cimarron River in Comanche County where it enters Oklahoma.

On the nearly level and gently sloping upland the predominant soils are deep, well drained, loamy soils formed from loess. (Exhibit 3) Slowly permeable clay soils are in the depressions. The sloping areas along drainageways are occupied mostly by deep, well drained loamy soils formed in calcareous loamy outwash. Some moderately deep and some shallow soils occur on steep slopes along the major stream valleys. South of the Cimarron River is an extensive area of sand hills. To the south of the sand hills there are sandy soils on undulating to hummocky topography. On the bottomland the soils are loamy to sandy. Most of the soils on bottomland are deep but they range from somewhat poorly drained to well drained.

Minerals

Several mineral deposits of economic value occur in the basin. These include sand and gravel, volcanic ash, caliche,

stone and huge stores of oil and natural gas. (Exhibit 4)

Sand and gravel deposits are found in the Ogallala and Meade formations in Clark, Meade, Seward, and Grant Counties. They are also found along major stream courses. Road material and concrete aggregate are the chief uses. The Meade formation also yields caliche and building stone. The caliche is used as a road surface material. The soft limestone when case hardened, and the mortar beds in the Meade formation are quite durable as building materials.

Many volcanic ash deposits have been located in Meade County. A few of the deposits have been worked commercially. Other known areas of ash occur in Clark, Gray, Seward, Morton, Stevens, and Stanton Counties. Volcanic ash may be used as an abrasive, as a ceramic filler, in ceramic glazes, in glass and vitreous enamels, as a light weight aggregate, and in cellular blocks.

The Cheyenne sandstone in Clark and Comanche Counties may contain usable amounts of sandstone as raw material for glass manufacture. Favorable studies for this use have been made in counties just east of the unit.

Minor amounts of salt and gypsum have been found but not of sufficient quantity for commercial use.

Land Use and Management

The Cimarron Unit is within the Central Great Plains Winter Wheat and Range Region of the United States. It is divided into three major land resource areas: area 72, the Central High Tablelands; area 77, the Southern High Plains; and area 78, the Central Rolling Red Plains. (Exhibit 5)

Land use for each land resource area in the Cimarron Unit is as follows:

Land Resource Area	Cropland		Rangeland		Forest		Other		Total Acres
	Acres	%	Acres	%	Acres	%	Acres	%	
072	1,793,088	89	128,764	7	-	-	86,471	4	2,008,323
077	705,184	66	308,957	29	6,386	1	46,257	4	1,066,784
078	388,442	31	750,684	59	-	-	130,079	10	1,269,205
Total	2,886,714	67	1,188,405	27	6,386	<1	262,807	6	4,344,312

Land use for the unit by land capability class is shown in the following table:

Land Capability Class	Acres by Land Use				Total
	Cropland	Rangeland	Forest	Other	
I	0	0	0	0	0
II	583,571	77,563	0	53,350	714,484
III	1,678,189	127,016	0	84,842	1,890,047
IV	490,635	233,465	0	34,319	758,419
V	0	7,792	0	10,276	18,068
VI	130,410	660,894	0	28,010	819,314
VII	3,909	81,675	6,386	52,010	143,980
VIII	0	0	0	0	0
Total	2,886,714	1,188,405	6,386	262,807	4,344,312

Approximately 45 percent of the unit lies in land resource area 72. Nearly all the land is in farms and ranches. Eighty-nine percent of the area is cropland, of which 18 percent is irrigated. Winter wheat is the main cash crop. Grain sorghum is the only other crop utilizing any large acreage. Corn and grain sorghum are the principal irrigated crops.

Rangeland occupies 7 percent of land resource area 72 within the unit. The Cimarron National Grassland is partly within this LRA. On the hardland or tight soil areas, shortgrasses such as buffalograss and blue grama are predominant species. During periods when moisture conditions are favorable, increases in midgrasses may occur, mainly western wheatgrass, galleta, and sideoats grama. Tall and midgrasses occupy the sandy range sites. Sand and little bluestem, sand dropseed, sand lovegrass, and switchgrass are common to these areas.

Cities and towns, roads, highways, railroads, water areas, and other non-agricultural land uses account for four percent of land resource area 72.

Land capability classes within land resource area 72 range from II through VII. Ninety-five percent of the area is classified as II, III, or IV and 91 percent of this is utilized for crop production. Climate, specifically the low annual precipitation, restricts the better lands from a capability class I designation.

The southwest portion of the unit lies in land resource area 77, the Southern High Plains. Nearly 25 percent of the unit is accounted for in this land resource area. Land use consists of 66 percent cropland, 29 percent rangeland, 1 percent forest land, and 4 percent other. Thirteen percent of the cropland is irrigated. Wheat and grain sorghum are the major dryland crops and corn and grain sorghum the principal irrigated crops.

A large part of land resource area 77 rangeland consists of breaks along the Cimarron River and its tributaries. The Cimarron National Grassland is partly within this LRA. Those grasses found on the hardland areas or sandy areas, as mentioned for land resource area 72, predominate in this area also.

Cities and towns, roads, railroads, water areas, etc. make up the four percent of land cataloged as other in land resource area 77.

Land capability classes II through VII can be found in the Southern High Plains area of the unit. Forty percent of this area is classified as land capability class III of which 90 percent is cropland. Climate, as in land resource area 72, restricts the better lands from a class I designation.

IRRIGATED PASTURE IN THE SOUTHERN HIGH PLAINS, STEVENS COUNTY.

RANGE BREAKS ALONG THE CIMARRON RIVER IN SEWARD COUNTY.

The southeast area of the unit is within land resource area 78, the Central Rolling Red Plains. Approximately 30 percent of the unit lies within this resource area. Rangeland occupies 59 percent of the area. Native grasses found in land resource areas 72 and 77 are the major species found in this area. Cropland represents about 31 percent of the total area. Wheat, grain sorghum, and alfalfa occupy the major portion of the cropland area. Only 3 percent of the cropland is irrigated. Corn and grain sorghum are grown on most of the irrigated acreage.

The remaining land in resource area 78 is utilized for purposes other than for direct agricultural use.

Water Resources

Surface Water - Stream flow records applicable to the Cimarron Unit are rather limited. There is only one continuous record stream gaging station in the unit at the present time on Bear Creek near Johnson, Kansas. Streamflow information is also provided by a continuous record station on the Cimarron River near Forgan, Oklahoma. There are seven partial record stations in the unit, two on tributaries of the North Fork of the Cimarron River, two on tributaries of the Cimarron River, two on Crooked Creek, and one on Kiger Creek. Records for the Cimarron are also available for the period 1943 through 1965 near Mocane, Oklahoma, about twelve river miles downstream from the Forgan gage. Limited records are also available for discontinued stations on the Cimarron River near Satanta and Liberal and on Crooked Creek near the Oklahoma border.

Average annual runoff is highly variable within the unit. (Exhibit 6) Runoff does not occur from most of the land in the unit because of the relatively low precipitation, poorly defined drainage, and high rate of evaporation. Streamflow in the Cimarron River and its tributaries is generally low and intermittent with most of the flow coming into the state from the west. Low flows in the river disappear in certain reaches due to sandy conditions and reappear further downstream. On the basis of limited data estimates of average annual runoff range from 0-0.14 inch over much of the western half of the unit to about 1.0 inch in the extreme eastern portion.

Lack of data on annual yield in streams and on maximum and minimum daily discharges is a serious handicap to water resource planning. The variation in flow for different time periods is of particular importance where a stream is to be used for water supply purposes. Records for the discontinued Crooked Creek station near the Oklahoma border are not typical of flows in the unit because of artesian contribution to the stream. Streams of the eastern one-fourth of the unit are probably the only ones with enough reliable flow for water supply development.

Flood data on tributaries of the unit are meager because of limited streamflow records. The maximum flood of record on Crooked Creek at the Nye gage (813 square miles contributing drainage area) was 13,600 cfs, May 20, 1955. Bear Creek in the northwest part of the unit is an intermittent stream with no clearly defined outlet. Its drainage area includes about 1,720 square miles in Colorado and Kansas. Large flows passing down Bear Creek fill the many pot holes of eastern Stanton County and western Grant County before breaking over into Lakin Draw to enter the North Fork Cimarron River near Ulysses, Kansas. Unofficial records kept by local residents show that this event has occurred four times since 1932. Numerous other storms have caused flooding along Bear Creek but did not reach the North Fork Cimarron River.

Physical and chemical quality records are available for one station in the Cimarron Unit. This station, established in 1962, collects information annually for the Cimarron River near Liberal.

Groundwater - Sources of water in the Cimarron River Basin consist of stream flow, numerous springs, some ponds, and groundwater. (Exhibit 22) Groundwater is found in abundance on the High Plains where a thick mantle of Pleistocene sands and gravels or where the Ogallala formation overlies more dense materials. The water level in most wells is less than 200 feet below the surface. The groundwater gradient is usually east to southeast. In general, High Plains wells will produce 500 to 1,000 gallons per minute. As much as 700 feet of permeable material may be saturated. (Exhibit 24) Early Pleistocene sands and gravels are the largest producers followed by the Ogallala, Upper Pleistocene, and Dakota formations. The Water Resources Board estimates 160,000,000 acre feet of groundwater in storage available to wells.

Conditions are favorable for springs at the contact of younger formations with the Permian Red Beds. In this zone of contact, springs flowing less than 100 gallons per minute are found in Kiowa, Meade, Clark, and Comanche Counties. This creates a base flow for many tributary streams.

The Red Hills with exposed Permian Red Beds have no continuous aquifer. Little groundwater may be found in some areas. Upland wells usually yield less than 10 gallons per minute. Shallow wells in the sandy alluvium along Bluff Creek and the Cimarron River may produce 100 to 500 gallons per minute.

Fish and Wildlife Resources

Fishing in the Cimarron Unit is mostly limited to impounded water. The Cimarron River provides only a limited amount of fishing. (Exhibits 8 and 9)

There is a total surface area of 688 acres of water in five impoundments in the unit. Figures of the Soil Conservation Service show approximately 950 farm ponds in the Cimarron Unit in 1967 of which 868 are located in Clark and Meade Counties. Due to high evaporation losses and frequent drought conditions, the farm ponds in the unit provide only a limited amount of fishing opportunity.

Wildlife of the Cimarron Unit is influenced by the semiarid climate. Small amounts of timber or wooded areas limit the number of species such as whitetail deer and squirrels within the unit. The rough rolling sandhills-sagebrush areas provide habitat for antelope and lesser prairie chicken. (Exhibit 10) Scaled quail inhabit predominantly grassy areas which have scattered cover formed by sage brush and yucca plants. The Cimarron Unit contains the primary areas of Kansas where scaled quail are hunted.

Whitetail and mule deer, pheasant, bobwhite and scaled quail, dove, cottontail and jackrabbit, fox squirrel, and waterfowl are game animals found in the unit. Deer are the only big game species presently hunted in the Cimarron Unit. Populations of antelope and Rio Grande turkey are increasing and with proper habitat management it is anticipated their numbers will increase to levels that will permit harvesting.

The more predominant furbearers of this area include mink, muskrat, beaver, raccoon, and coyote. Populations of red and swift fox are present. Populations of black-tailed prairie dogs and associated species are present in scattered dog towns throughout this area.

Upland game bird hunting provides most of the hunter recreation in the Cimarron Unit. Lesser prairie chicken was added to the list of harvestable game birds when the Forestry, Fish and Game Commission opened a two-day season in November 1970.

The limited amount of water area is a factor in waterfowl utilization of the Cimarron Unit. Meade Lake and the Cimarron River are the two major water areas used as resting and overwintering sites by waterfowl. During wet years, streams, ponds, pot holes, and marshy areas are utilized by migrating waterfowl. The Cimarron Unit is located within the Central Flyway and numerous species of waterfowl pass through the area during spring and fall migration. Many additional species of birds and mammals are present within the unit.

Forest Resources

Commercial forest lands occupy only 6,386 acres of the Cimarron Unit. (Exhibit 11) Most of these lands are in the eastern portion. Approximately 90 percent of these acres are classified as commercial forest land. The use of trees is generally restricted to windbreaks and shelterbelt plantings. These plantings have added substantially to the total timber volume, but these areas are not generally classified as commercial timberland. However, the use of trees for recreational purposes and wildlife habitat is increasing. Other small plantings for fence posts, poles, and other farm and ranch needs exist. Christmas tree plantings (evergreens) are also increasing.

Cottonwood, oak, elm, and ash are the most abundant species in the unit and are generally found in narrow strips on the stream bottoms. Most of the bottomland types have good growing sites and could produce high-quality hardwood timber, but tree quality tends to be poor because of the scattered, open growing conditions. The primary use and impact on the woodlands is grazing. Because of the adverse

climate, soil conditions, grazing and poor tree quality, these forested areas have little potential for commercial timber production.

CHRISTMAS TREE PLANTING IN STANTON COUNTY.
Photo by: U.S. Forest Service

Sawtimber volumes total approximately 13,000,000 board feet measured by the International 1/4-inch rule in the Cimarron Unit. (Exhibits 13 and 14)

The amount of growing stock totals about 7,745,000 cubic feet. All of the growing stock is hardwood. One hundred percent of the commercial forest land in the unit is in private ownership. (Exhibit 11)

Timber cut from the study area in 1964 (primarily fuel-wood and fence posts) amounted to only 74,000 board feet from sawtimber stands and 29,000 cubic feet from growing stock stands. (Exhibit 15) There are no sawmills operating in the unit. The quantity of timber and distance to markets apparently discourage timber buyers.

The annual sawtimber growth per acre is relatively low as a result of past cutting practices, fires, and grazing. Annual growth is expected to rise from about 540,000 board feet in 1964 to 1,000,000 board feet by 2020. (Exhibit 43)

Since timber cut is much less than growth, both sawtimber and growing stock inventories should rise until 2000. After 2000 the increase will diminish as cut draws closer to growth. The inventory found in 2020 should be approximately the same as 1964.

Quality of Natural Environment

Man has changed the natural environment. He has molded the landscape, changed the vegetative patterns, and re-routed the waters. When the settlers came they found these changes necessary if they were to survive. Windbreak tree plantings were made to slow the winds and catch the blowing snows. Irrigation was necessary to produce food and provide a cash income.

Man's net effect on the quality of environment in this unit may be judged as an improvement. Once a dry, short grass area with very little woody vegetation, there now is found the lush greenery and flowing water associated with irrigation. Trees grow along many of the streams and provide neat borders for the widely spaced farmsteads. The windbreaks and other wildlife plantings offer winter protection for many species of wildlife that could not exist here otherwise. The sky is usually clear, allowing full view of the landscape for many miles around.

The balance that now exists between agriculture and the natural environment did not come about without false starts. The plow was used on some lands that were not suited for cultivation and too much reliance was placed upon precipitation for needed moisture. Rangeland was also abused. The dust bowl days resulted. Many men gave up and left. Others stayed and have even improved that which existed when their fathers came to this area. Soil and water conservation practices and proper land use proved effective in holding the soil in place. Irrigation proved successful because of the abundance of groundwater, irrigable soils, and topography. Today people of this unit can boast of living in a true "garden spot".

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

Watershed Protection and Management

Erosion and Sediment Damage - Wind erosion is always a hazard on the High Plains and is serious during drought periods. It is more of a problem on sandy land causing drifts and a hummocky surface. Wind erosion may cause little permanent damage except in severe cases. The use of the land may be impaired until a vegetative cover is re-established. Water erosion is minor on the High Plains.

THIS IS A 100-ACRE BLOWOUT AREA IN STEVENS COUNTY.

The Red Hills have less soil blowing and more water erosion. In the rougher section of the Red Hills gullies are numerous, causing severe erosion. Sheet erosion is moderate on the sloping land. Little damage occurs on the flatter slopes.

Land stabilization problems in the unit are generally of an extent that may be solved through individual action with on-farm land treatment measures. The project approach to grade stabilization is not needed.

Sediment production from small watersheds in the Cimarron Basin is closely related to rainfall and topography. (Exhibit 16) Negligible amounts of sediment come from the Sand Hills and pot hole areas. The level high plains may produce as much as 0.10 acre foot per square mile annually while the dissected rolling plain may produce twice this amount. River breaks with gullies along the Cimarron show a yield of 0.2-0.5 ac.ft./sq.mi./yr. The Crooked Creek Watershed shows less than 0.1 ac.ft./sq.mi./yr. on the level plain of Gray County to 0.2 on the rolling plain of Meade County. The gullied Red Hills may produce more than 1.00 locally while in general the rate may be 0.2 to 0.5 ac.ft./sq.mi./yr.

Sediment is deposited in ponds, along stream banks, on floodplains, and at the terminal of Bear Creek. The soil damage from the deposition is small and difficult to assess.

Land Treatment Needs - Current conservation treatment adequately meets the conservation problems on 15 percent of the 1,793,088 acres of cropland in land resource area 72. (Exhibit 17) Residue management, mainly stubble mulching, and stripcropping are the principal dryland land treatment practices needed. The major irrigated land treatment need is planned irrigation systems.

Treatment is adequate on 26 percent of the rangeland in land resource area 72. Proper grazing use is the most needed practice. Range seeding is needed on 14 percent of the rangeland.

The land treatment problems have been adequately solved on 25 percent of the cropland acres in land resource area 77. Residue management and stripcropping are the most needed land treatment practices. Twenty-six percent of the cropland still needs stubble mulching and 33 percent of the area needs protection from blowing through stripcropping. More efficient application of water through planned irrigation systems is needed on 65,582 acres.

BENCH LEVELING, AS SHOWN IN HASKELL COUNTY, IMPROVES IRRIGATION EFFICIENCY.

Only 6 percent of the rangeland in land resource area 77 has been adequately treated. Proper grazing use is needed on nearly half of the 308,957 acres. Thirty-seven percent of the rangeland requires range seeding before it can be used to its capacity.

Land treatment measures have adequately solved the conservation problems on 35 percent of the cropland acres within land resource area 78. The application of terracing, strip cropping, and residue management will provide adequate treatment for over one-half of the area. Permanent cover should be established on 22,918 acres presently being cropped.

Over half of all the rangeland in land resource area 78 is adequately treated. To be adequately treated, proper grazing use needs to be practiced on 35 percent of the rangeland. In order to reduce competition of woody plants and establish a better cover for soil protection and forage production, brush control is needed on 80,323 acres.

The general discussion beginning on page 38 also applies to the reasons that residue management, stripcropping terracing, planned irrigation systems, proper grazing use, range seeding, and brush control are needed in this unit.

Woodlands - The general discussion beginning on page 192 also applies to watershed protection and management needs of the woodlands in this unit. These needs are quantified on page 109.

Floodwater and Sediment Damages

Flood problems related in this section are those occurring on tributary floodplains of the unit. Mainstem Cimarron River flood damages were not evaluated. (Exhibit 18a)

Most of the tributary streams in this unit do not have a significant flood damage problem. Streams in this category include: Big Sandy Creek and tributaries (Meade and Clark Counties); Fivemile and Bullard Creeks (Meade and Clark Counties); Bear, Day, and Spike Creeks (Clark County); Bluff and Cavalry Creeks and tributaries (Clark and Comanche Counties). The flood problem along these streams is held to a minimum because of the combination of natural factors including low runoff volumes, extreme flood peak attenuation, and low value floodplain lands. Flood damage in this group of watersheds is probably less than one dollar per acre of floodplain.

Crooked Creek and North Fork Cimarron River have a somewhat greater flood problem than the first group of watersheds. Low runoff volumes and peak attenuation act as natural flood problem reducers but high value floodplain and low channel capacity combine to produce significant flood damages in some reaches.

The watershed with the greatest flood damage problem is Bear Creek (Stanton, Hamilton, Grant, and Kearny Counties). Included in the Bear Creek subbasin is Little Bear Creek. Below the junction of Little Bear Creek with Big Bear the stream loses nearly all channel capacity and enters onto a large plain of rich irrigated land marked by depression or pot hole areas. Large flows spread over the irrigated land, fill the pot holes, break over the natural watershed boundary, flow down Lakin Draw, and enter the North Fork Cimarron River near Ulysses. Although flooding is infrequent, losses are

relatively high because of the large amount of irrigated land subject to flood flows.

THE GREATEST FLOODING PROBLEM IN THE CIMARRON RIVER UNIT IS ALONG BEAR CREEK IN STANTON COUNTY.

Damage estimates are presented in this report only for Crooked Creek, North Fork Cimarron River, and Bear Creek (including Little Bear). Agricultural areas suffer the greatest flood damage. An estimated 68,398 acres along tributary streams are subject to inundation by a 100-year frequency flood (a flood which has a one percent chance of occurring in any given year). Some 53,912 acres of cropland, 12,370 acres of pasture, and 2,116 acres of miscellaneous use (including channel and adjoining timber) would be inundated by this size flood. (Exhibit 18) 17,400 acres of the cropland are currently being irrigated.

Average annual crop damages based on 1980 projections of land use are estimated to be $407,000. Other agricultural damages average $151,800 annually within this unit. Other agricultural flood damages include damage by flooding of stored grain and hay, fences, farm buildings, and farm machinery. Included as other agricultural damage in this unit is damage to land that has been leveled for irrigation. This item reflects re-leveling costs and costs of cleaning out and repairing ditches and head structures. Floodplain

scour and sediment damages are estimated to average $12,300 annually. Such damages have occurred on about 6,840 acres of floodplain lands. Average annual agricultural damages total $571,100.

Road and bridge damage is the major non-agricultural item, averaging $48,600 annually. Road and bridge damage occurring at crossings of upland draws and gullies was not evaluated but probably totals more than that occurring along floodplains. Urban floodwater damage in the city of Meade was evaluated at $200 annually. Damages by flooding are primarily cleanup of sediment and debris in the city park and loss in valuation of property. Total non-agricultural damages are estimated to be $48,800 on an average annual basis.

Indirect damage is estimated to average $59,500 annually. Indirect losses include interruption of transportation and utilities and loss of business to those serving agricultural communities.

Total evaluated tributary floodplain damages, including agricultural, non-agricultural, and indirect losses are estimated to average $679,400 annually.

<u>Agricultural Water Management</u>

Drainage - Problems encountered were those of surface water removal. A large portion of this unit is nearly flat tableland that slopes 10-15 feet per mile to the east. The surface of this land is marked with many shallow pot holes. Drainage is indefinite, generally leading surface runoff overland and along road ditches until it collects in depressional areas or "pot holes." A portion of water collected in pot holes is added to groundwater but most is lost to evaporation because of the large surface area to depth ratios and relatively impermeable soils. In some years crops cannot be grown in these pot holes due to the long duration of flooding.

Lack of a defined stream pattern on the widely irrigable tableland presents problems in tailwater removal. Reforming land during the irrigation development process concentrates excess water at the lower end of fields. If no outlet is provided, excess water may flow onto neighboring fields. This problem is sometimes solved by making use of the natural pot holes.

The 1967 Conservation Needs Inventory places the remaining cropland drainage problem area size at 20,321 acres.

Irrigation Demands - Irrigation uses considerably more water than all other uses combined in this unit. (Exhibits 19, 26, and 31) In 1969, there were an estimated 1,600,000 acre feet of water used to irrigate 510,000 acres in the Cimarron Unit. At $30 an acre foot (see page 43) this gave an increase in income of $48 million due to irrigation. Irrigation acreage and water demand are expected to increase greatly in the next 50 years. (Exhibit 20) The location of tracts which had water rights for irrigation in 1966 gives an indication of where the irrigation development is taking place. (Exhibit 21)

IRRIGATED CORN AND SORGHUM IN MEADE COUNTY.

Groundwater Depletion - Nearly all irrigation in the Cimarron Unit is from groundwater. (Exhibit 21) The only surface water irrigation rights are for the floodwaters of Bear Creek which are very erratic. The unit is well blessed with ample groundwater supplies and land suitable for irrigation. (Exhibit 20) A large amount of water storage

is provided by the saturated thickness of unconsolidated deposits which range up to 700 feet deep. (Exhibit 20) However, the annual pumpage for irrigation far exceeds the natural recharge in the unit and the groundwater in storage is being depleted. (Exhibit 19) There are areas where the groundwater level has dropped as much as 90 feet in the past 30 years. (Exhibits 23 and 24) There is a possibility that some areas of the unit will have been depleted to the point where the groundwater supplies will be inadequate to support irrigation by the year 2020.

Surface water impoundments for irrigation are not practical in this unit (see page 104). The greatest need for irrigation in the Cimarron Unit is to conserve the groundwater reservoir. There is a need for more water conserving land treatment measures. There is also a need for programs which will help speed the widespread adoption of efficient water-saving irrigation techniques. A more complete discussion of this subject is included on page 44.

The quality of groundwater in the unit is generally acceptable for irrigation. (Exhibit 22)

Rural Domestic and Livestock Water - The general discussion beginning on page 44 also applies to rural domestic and livestock water needs in this unit. (Exhibits 26, 27, 28, and 31)

Generally the groundwater supply is adequate in quantity and satisfactory in quality to meet rural household and livestock needs. (Exhibit 22) Farmers and ranchers depend upon surface water as a partial source of supply in the eastern portion of the unit, primarily in Meade, Clark, and Comanche Counties.

Non-Agricultural Water Management

Municipal and Industrial Water Needs - Municipal water use will generally increase in the unit particularly in Grant and Seward Counties which have the two largest cities. (Exhibits 26 and 31) All municipalities in the unit use groundwater. (Exhibit 27) Generally the groundwater supplies are of adequate quantity and satisfactory quality for meeting the municipal needs.

All industrial water in the unit is supplied from groundwater. (Exhibit 27) The industrial water use is fairly high because of helium and natural gas production. The projected industrial water demands increase in 1980, but because of the reduction in natural gas production by year 2000, they will decrease between 1980 and 2000. (Exhibit 19) It will increase again by the year 2020 due primarily to an expected increase in non-metallic mining. Groundwater supplies should be adequate to provide the industrial demands even if supplies should become too low to support irrigation.

Recreation - The recreation water needs are based on the present and estimated future population in each county. Comparing available recreation areas with recreation demands within a single county may indicate a considerable need or surplus for that county. (Exhibit 29) However, adjoining counties may have surpluses or deficits which balance out the totals over a multi-county area. For example, Meade County shows a surplus for boating because of Meade County State Lake while adjoining Seward County shows a deficit in boating since there are no impoundments in that county. However, Seward County people probably make considerable use of the Meade County State Lake.

The Cimarron Unit is extremely short of water for boating, fishing, and swimming. (Exhibit 30) The only boating available in the unit is in the state lakes in Clark and Meade Counties. These are limited to fishing so there is no water area suitable for sail boating, water skiing, and high speed pleasure boating. The problems of low rainfall and topography unfavorable for impoundments make it extremely difficult to provide any sizeable and stable bodies of water. The few sites that are suitable for large impoundments are not economically feasible even including benefits to flood control, water supply, and pollution abatement.

Fish and Wildlife - The general discussion beginning on page 47 also applies to the fish and wildlife problems and needs in this unit.

Pollution

The general discussion beginning on page 48 also applies to pollution problems in this unit. (Exhibits 19, 28, 31, and 32)

LARGE NUMBERS OF CATTLE IN COMMERCIAL FEEDLOTS CREATE A POLLUTION PROBLEM. WASTES FROM THIS FEEDLOT IN SEWARD COUNTY ARE IMPOUNDED IN HOLDING PONDS.

Phreatophytes

In 1967 there were about 14,000 acres of woody phreatophytes in the Cimarron Unit. Most of this acreage occurs along the Cimarron River. The general discussion concerning problems caused by phreatophytes in the Upper Arkansas Unit (pages 50-52) is also applicable to this unit.

Range and Forest Fires

Fire is a constant threat to the Cimarron National Grassland especially during periods of continued drought. The users of the grasslands are conscious of this fact and are well equipped to handle most fires. The oil companies, county, local citizens, and the Grazing Association respond to action on all fires. In 1963, a 6,500 acre man-caused fire and several small lightning-caused fires occurred on the Cimarron Grassland. Damage to improvements was considerable; however, there was no permanent damage to the resource. Fires spread rapidly during periods of dry weather and high wind making them difficult to contain. In most cases, the extent of damage caused by fire is limited to the current year's growth and

accumulated litter. Some soil erosion from wind usually results following a fire but root damage to permanent vegetation is minor. With increased use of the grasslands, fires caused by man are expected to increase.

Following are the number of fires and acres burned by major cause for the five-year period 1963-1967 for protected state and private land (excludes Cimarron National Grassland) in the Cimarron Unit:

Item	Year 1963	1964	1965	1966	1967	5-yr. Ave.
No. of lightning-caused fires	0	2	4	9	8	5
No. of man-caused fires	0	10	13	38	42	21
Area burned[1/] - acres	0	887	402	3,917	5,544	2,150

1/ Includes organized rural fire districts only

A general discussion of the basin-wide range and forest fire problem is included in the Walnut-Verdigris Unit narrative beginning on page 199.

Impairment of Natural Beauty

Periods of insufficient precipitation cause a widespread loss of natural beauty. Dryland crops become brown and withered. Trees have less foliage than during a normal year. Grasses do not green and the usual mixture of wildflowers are not seen. Strong, hot winds are usually present to add to the problem by increasing evaporation and causing unprotected soil to blow. Dust storms reduce visibility and at their worst leave a scene of desolation.

Erosion of unprotected cropland in the rolling eastern portion of the unit detracts from the natural beauty. Loss of topsoil has reduced productive capacity and crop foliage is generally sparse. Gullies mar the landscape. This scene is a marked contrast to that found where conservation measures have been established.

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Land Treatment

The general discussion beginning on page 53 also applies to programs for accomplishing land treatment in this unit.

In the Cimarron Unit, the first soil conservation district was organized in Grant County in May 1940 and the last in Stevens County in June 1949. To date, 20 percent of the total cropland acres and 38 percent of the total rangeland acres have been adequately treated.

Upstream Watershed Projects

The general discussion beginning on page 53 also applies to watershed program provisions in this unit.

There have been no applications for assistance under P.L. 566 in this unit.* Interest in formation of a watershed district covering the entire Bear Creek subbasin has been increasing during the last few years. A steering committee has been formed and is currently promoting formation of a watershed district. This group has expressed interest in making application for P.L. 566 assistance on the Little Bear Creek portion.

Resource Conservation and Development Projects

The general discussion of program provisions beginning on page 148 also applies to the resource conservation and development program in this unit. A portion of the authorized Sunflower project is included in this unit (see pages 13-14 for current RC&D status and basin area involved).

Flood Control Projects

There are no local flood control projects existing, authorized, or under study in this unit. The Corps of Engineers, Tulsa District, is currently conducting a comprehensive survey investigation including this area. Reservoir site studies include mainstem Cimarron near Englewood and Bluff Creek near Protection.

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* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

Irrigation

Irrigation development has increased rapidly since 1945. Prolonged droughts, abundant groundwater, and availability of relatively inexpensive natural gas as a pumping fuel are important factors relating to irrigation expansion. Irrigated acreage expanded from 35,290 acres to 251,610 acres in the period 1950-1957. A current estimate puts the irrigated acreage at 560,000 acres compared to the state total of 1,700,000 acres. Groundwater is the source for 1,270,000 acre feet of water required annually. There is very little use made of surface water for irrigation in this unit although there are surface water rights for this purpose. Irrigation districts have not been organized in this unit. (Exhibits 19, 20, 21, and 22)

Drainage

One drainage district is active in this unit. The Copenhaver Drainage District of Meade County constructed improvements in 1954 for the purpose of draining 2,400 acres of depressional areas west of Fowler.

Water Supplies for Rural Domestic and Livestock Uses

The rural water district approach has not been tried as a measure to meet local water needs in this unit.

Municipal and Industrial Water Use

No communities or industries in the unit rely on surface water supplies. (Exhibit 27)

Recreation

The general discussion of the Land and Water Conservation Fund Act beginning on page 56 also applies to this unit.

Two state lakes and one private lake provide the main water-related recreational facilities of the unit. (Exhibit 8) Clark County State Lake is supplied entirely from surface water while the Meade County State Lake is partially supplied from springs. Because of the small amount of runoff available for storage, the lakes are quite small. The Clark

County State Lake is the largest having a maximum surface area of 337 acres and a maximum capacity of 7,660 acre feet. Meade County State Lake has a surface area of 100 acres. A private lake in Clark County has a surface area of 180 acres. The Ulysses City Lake has a potential surface area of 44 acres but is generally too low to provide a significant amount of fishing.

Fish and Wildlife

Forestry, Fish and Game Commission biologists conduct surveys and evaluate fish and wildlife within the unit annually. Fish stocking and rehabilitation programs are initiated when needed and when funds are available.

The Forestry, Fish and Game Commission has recently transplanted wild Rio-Grande turkeys in the unit with apparent success. (Exhibit 10)

Two areas have been designated as public hunting areas in the Cimarron Unit. (Exhibit 8) The Forestry, Fish and Game Commission designated a 1,043 acre area which includes Clark County State Lake. The other area, Cimarron National Grassland in Morton County, contains 107,000 acres and is open to the public by the U. S. Forest Service.

Forests and Grasslands

The Cimarron National Grassland contains approximately 107,000 acres in Morton and Stevens Counties. These lands, administered by the Forest Service, are managed under principles of multiple use to produce a sustained yield of products and services as authorized by the Multiple Use Act of June 12, 1960. The Multiple Use principle provides for management of the resources so they are utilized in a combination that will best meet the needs of the American people.

Water is an essential element in the use and management of renewable resources. The Forest Service is conducting studies to determine the effects of various plants and land uses upon the yield of water. The objectives are to maintain and stabilize a suitable plant cover, to increase water yield, to improve water quality, and to help prevent and control erosion and floods.

Deteriorated watersheds are being restored by controlling erosion in gullies, channels, roads and trails; by revegatating the land; and by applying other land treatment measures. A program of watershed management is being carried out. New methods and practices are applied as they are developed and proved.

The National Grasslands are important for the recreation, fishing, and hunting enjoyment of area residents.

Cottonwood and willow along the Cimarron River channel, livestock windbreaks, and old homestead tree plantings comprise the timber on the Cimarron National Grassland. The timber has very little economic value for lumber or wood products. It does have high values for recreation, wildlife habitat, protective values, and purely aesthetic and historical value.

A DENSE, MIXED STAND OF SALT CEDAR, WILLOW, AND COTTONWOOD GROWS ALONG THE CIMARRON RIVER IN THE CIMARRON NATIONAL GRASSLAND, MORTON COUNTY.

Photo by: U.S. Forest Service

The development and management of the rangeland has three major objectives: (1) proper stocking and improvement of the range resource to achieve desirable watershed

conditions, (2) making lands suitable for livestock grazing through full development of the range resource with due regard to other resources and uses, and (3) eliminating livestock use on areas unsuited to grazing.

Projects under way include conversion of non-productive lands from brush to grass, re-planting deteriorated ranges and chemical spraying to control noxious and poisonous plants. Proper livestock distribution over the range is achieved through fencing, developing of watering places, and proper location of salt. These improvements are built by both the Forest Service and permittees.

The forage resource on the Grassland is important in maintaining one of the area's key industries. Grazing of livestock on the National Grassland will continue to be an important Grassland use.

The Cimarron National Grassland is managed under the same multiple use and sustained yield policies as the national forests.

Cooperative State-Federal Forestry Programs

The Walnut-Verdigris Unit includes discussion of cooperative state-federal forestry programs beginning on page 212.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Land Use and Conservation Treatment

Land treatment measures have been installed on 20 percent of the cropland area. Residue management and stripcropping are the major conservation needs for the dryland farming area. The most needed treatment on irrigated land is planned irrigation systems to efficiently convey and apply water without excessive erosion or water losses. Permanent cover should be established on approximately 61,420 acres. Over one-third of the rangeland has received adequate conservation treatment. The principal measures needed to complete treatment of the rangeland are proper grazing use, range seeding, and brush control.

A large part of the unit's woodlands are on sites capable of excellent timber growth--over two-thirds are rich bottomland and side drainage sites. However, only one acre out of three is adequately stocked at present.

It is reasonable to project that about 57 percent of the cropland treatment needs and about 68 percent of the rangeland treatment needs can be accomplished by the year 2000. Projections assume continuation of current incentive programs and are based upon established trends.

Upstream Impoundment Sites

Nearly 40 percent of the unit is flat or very gently rolling and does not have any potential for floodwater retarding structure site development. This area is coincident with a large part of the area that does not have appreciable flood problems.

Floodwater retarding structure sites are generally available in the remainder of the unit. Potential physically feasible sites are available close to primary damage areas. (Exhibit 36) A total of 406 sites were examined during this investigation. Data was developed for 116 of these sites. Site characteristics range from poor to excellent. Contrary

to criteria for storing water over long periods of time for supply purposes, shallow reservoirs of large surface area will generally produce flood control at lower cost than narrow, deep reservoirs. This may not be true for excessively long dams. About 20 percent of sites studied were classified as having better than average storage potential as floodwater retarding reservoirs. Sites typical of those having above average potential for flood control reservoirs are found in the upper one half of the Crooked Creek drainage area. Nearly 40 percent of the sites studied were judged to be inefficient for floodwater storage. Excessive costs may also be encountered because of involvement with man-made improvements including roads, pipelines, farmsteads, or railroads. A relatively low proportion of sites studied fell into this category.

Drainage area size of sites studied ranged from 1 to 500 square miles with an average of about 22. Total drainage area controlled by sites investigated is 2,570 square miles or 38 percent of the unit area. Some sites are in series. Many of the sites studied are in pasture or involve only the poorer dryland cropland.

Channel Work

Generally in this unit channel improvement is not feasible as a measure added to land treatment and floodwater retarding structures. Channel improvement is not feasible for flood control on Bear Creek because of outlet conditions. Physical feasibility is limited on other watersheds of the unit because of unstable soil conditions.

Agricultural Water Management

Storage - Surface water storage for irrigation use is not efficient in this unit except in a few sites where storage would be deep in relation to surface areas. (Exhibit 37) Shallow reservoirs with large surface areas expose too much area to high evaporation and seepage rates. Low water yield in relation to loss and use requires abnormally high carry over storages in order to provide needed water over multi-annual drought periods. In most cases, stream yields are not enough to take advantage of the physical storage available. Irrigation storage may be physically feasible by selection of sites with large drainage areas and deep storage but the cost would be high in relation to the potentially irrigable area.

The general discussion beginning on page 61 also applies to the potential for rural domestic and livestock water supply development and groundwater recharge in this unit.

Nineteen sites were recognized to have some degree of physical potential for multiple-purpose development including, if needed, agricultural water storage. About one half of these sites were classified as being above average in water storage characteristics. Most of the sites that have promising physical potential for multiple-purpose development are in the Bluff and Sand Creek Watersheds of Clark and Comanche Counties. Here yield will limit potential development. (Exhibit 37)

Drainage - The discussion on page 61 is also applicable to the potential solution of drainage problems within this unit.

Non-Agricultural Water Management

The general discussion beginning on page 62 also applies to potential development of water supplies for municipal-industrial, recreation, fish and wildlife, or water quality control in this unit.

Availability of Land and Water for Potential Development

Thirteen reservoir sites were recognized as having limited multiple-purpose development potential in this unit. However, the yield into these sites will seldom be adequate to maintain the water yield much above the 100 year sediment storage pool.

Cropland would be involved in development of the full storage potential of most sites. A large part of the cropland would be non-irrigated. The possibilities of encroachment on roads, farmsteads, or pipelines increase as storage is increased in most sites. Railroads or highways would be involved in a few cases. No towns would be affected by these sites. Other larger sites not investigated are likely to involve more serious encroachment on physical improvements.

OPPORTUNITIES FOR DEVELOPMENT WITH USDA PROGRAMS

Land Treatment Measures

The general discussion beginning on page 65 also applies to opportunities for development of land treatment in this unit.

The total cost of installing the needed land treatment measures listed in Exhibit 17 for the Cimarron Unit is estimated at $85,600,000.

Upstream Watershed Projects

The general discussion of program provisions beginning on page 66 also applies to opportunities for P.L. 566 development in this unit.

Early Action Projects - There are no projects in this unit recommended for early project action. High current interest rates, high costs, and present evaluation procedures are reasons that projects studied are not economically feasible and not recommended for early action.

Long Range Projects - One subbasin of this unit may merit future consideration for development under the P.L. 566 watershed program. This project should be re-evaluated if economic factors improve. Little Bear Creek (CNI Nos. 1r1(a)-4, 5, and 6) includes an area of 522 square miles or 334,080 acres. Approximately 149,146 acres are in Baca and Prowers Counties, Colorado, and 184,934 acres are in Hamilton and Stanton Counties, Kansas. The subbasin size exceeds the 250,000 acre limitation of P.L. 566. Applications for assistance will need to be made on two watersheds in order to comply with P.L. 566. These watersheds would be planned concurrently.

Interest in formation of a watershed district covering the entire Bear Creek basin has been increasing during the

last few years. The first organized interest was shown by the Hamilton and Stanton County Soil Conservation Districts. A steering committee has been formed and is currently promoting formation of a watershed district and immediate application for assistance under P.L. 566. A possible sponsor for application could be a Groundwater Management District which is now under consideration.

Interest within Little Bear Creek Watershed is primarily for flood protection. The interest further east in Bear Creek basin includes the additional goal of groundwater recharge. The support of Colorado interests is vital to any development in Bear Creek basin. Farmers in Colorado have indicated their support of watershed development in Little Bear Creek Watershed.

Complete land treatment is essential to floodwater and erosion control in the Bear Creek basin. The most effective measures are level terraces and crop residue management. Long continuous slopes, some extending 2-3 miles, present a problem to establishing all the terraces needed. A complete system for one slope may involve several landowners and will require cooperation from each owner if all work is to be done. The educational program and organization that can be provided through a watershed district working with a well-developed work plan will help to establish the degree of land treatment needed.

A total of 20 potential floodwater retarding structure sites were examined during this investigation. Some of these sites are in Colorado. Approximately 50 percent of the land involved in the reservoirs would be cropland. It would be possible to control about 52 percent of Little Bear Creek with seven sites. General information about a possible seven structure system is summarized below:

Summary of Structure Data for a Potential System[1/]
Little Bear Creek Watershed
Arkansas River Basin

No. of Sites	Drainage Area Controlled sq. mi.	Storage Capacity Sediment ac.ft.	Storage Capacity Detention ac.ft.	Storage Capacity Other ac.ft.	Surface Area Sediment Pool acres	Surface Area Detention Pool acres
7	270.0	1,441	33,006	0	252	2,902

1/ Other combinations of structures are also possible.

None of the potential sites were estimated as multiple-purpose reservoirs. The only two sites that might have large enough drainage areas to give a somewhat reliable gross yield are very poor sites for water storage as they have large surface areas and shallow depths.

Flood prevention by P.L. 566 structures in Bear Creek basin outside of Little Bear Creek Watershed does not appear feasible. To obtain control by reservoirs of a size eligible under P.L. 566 would require structures in series. The maximum combined drainage area of structures in series is limited to about 390 square miles by P.L. 566. This would be a small amount of control in relation to the total drainage area.

Large structure sites exist at downstream locations that would give a good level of control. These will need to be developed under programs other than P.L. 566.

Public Law 566 development of land treatment needed in the basin can be a very effective means of controlling runoff and erosion.

Cooperative State-Federal Forestry Programs

Forest land treatment measures are needed to supply quality timber for present and future generations. The following table lists estimated land treatment measures proposed on state and private forest lands, Cimarron Unit, to 1980 (estimated cost - $581,400):

Item	Unit	Amount
Timber surveys	Acres	5,900
Forest management (technical assistance) timber thinning, pruning, and releasing	Acres	3,500
Growing and distribution of seedling trees for reforestation and wind-barriers	Trees	6,000,000
Tree planting and seeding	Acres	8,200
Insect and disease control program	Acres	5,500
Fire Control Program	Miles	2,000
	Acres	4,000
Cooperative watershed protection and flood prevention	Acres	14,000

The land treatment measures will be maintained by landowners and operators. The Forest Service will maintain the forest land treatment measures on the grassland administered by them. They will help private owners manage their forests in such a way as to provide habitat for birds and wildlife, access for recreation, water harvest and forage for livestock. Obstacles to reforestation include drought, excessive vegetative competition, and damage to seedling trees by rodents, livestock, and other agents.

National Grassland Development and Multiple Use Programs

The National Grassland program is geared to meet the needs of the next 10-15 years.

The U. S. Forest Service will install the treatment needed on the National Grasslands. (Exhibit 44) Land treatment measures are important features of the basin-wide program. Area treatment will consist of range forage improvement, fencing, and water developments to control

grazing, wildlife water developments, wildlife seeding and plantings, gully stabilization, stabilizing blowouts, water storage structures, construction of roads, rehabilitation of roads and trails, and timber stand improvement at recreation sites.

PITTING ON HARDLAND HELPS REDUCE WATER RUNOFF IN THE CIMARRON NATIONAL GRASSLAND IN MORTON COUNTY.

Photo by: U.S. Forest Service

The Forest Service anticipates receiving part of the installation cost through its regular funding.

All of the land treatment will not be accomplished by the National Forest Development and Multiple-Use Programs. Many of these needs will be met through the regular programs that are in effect at this time in Clarke-McNary Act, Cooperative Forest Management Act, Rural Area Development, National Forest Administration, and others.

The Kansas State Extension Forester, in cooperation with the U. S. Forest Service, will supervise the installation of forestry measures on private land.

The programs on National Grassland areas bring the multiple use concept into reality. It will take manpower

and funds. The jobs will require knowledge, diversified experience and judgment on the part of the resource managers to coordinate the range, recreation, timber, watershed and wildlife resources.

Timber Resources - There will continue to be a demand for trees for other than wood and timber on the area. Successful establishment and proper management of demonstration tree plantings will encourage plantings on private lands in the locality.

Existing trees will be managed for aesthetic and recreational values and for demonstration purposes such as windbreaks, livestock protection, and wildlife habitat. This program will be expanded to provide for a wider range of demonstrations.

Range Resources - Grazing of cattle on the Cimarron National Grassland will continue to be one of the major resource uses. There will be increased demand for use of this resource. More livestock use may be allowed in the future because of improved management and additional range improvements, such as providing more stockwater, fencing, and revegetation. The ranges will continue to be important to the local economy.

Recreation Resources - Opportunities exist for development of new recreation facilities. The Kansas Forestry, Fish and Game Commission has an active program for developing additional fishing ponds and game bird habitat to improve the recreation use on the National Grassland. For general enjoyment and sightseeing, the Cimarron National Grassland offers visible evidence of part of the old Santa Fe Trail; Point of Rocks which was a landmark of the trail; and Middle Springs, presently known as Spring Creek, which was a camping spot on the trail. Artifacts of ancient cultures and of historical interest are found in the area.

Wildlife Habitat Resources - The hunter and fisherman visits are increasing on the Cimarron National Grassland. This use is expected to increase as a large part of the recreational use is tied to the wildlife resource.

The object of habitat management is to make it fully productive to support fish and game population to help meet the needs of public use and enjoyment. The wildlife habitat

management proposals include, (a) completion of management and improvement plans, assuring proper coordination between wildlife habitat management and other resources, (b) inventory and evaluation of wildlife habitat resources in cooperation with other federal agencies and with the state as a basis for orderly development of habitat improvement and coordination programs, including big game, game bird, small game, and fishing, (c) improvement of food and cover on key wildlife areas, (d) development of wildlife openings, food patches, and game ways, (e) improvement of fishing by constructing and maintaining additional fish ponds, and (f) encouragement of proper game and fish harvest by sportsmen.

Fire Control - An increase in the number of man-caused fires can be expected with expanding public use unless an aggressive fire prevention program is carried out. Also, a more intensive detection and suppression program will be essential.

The objective will be to hold fire damage below the level which will seriously interfere with optimum yield of water, timber, forage, and recreation values.

Program proposals include: reduction of fire hazards, replanning fire control needs and intensifying action for protection, detection, and suppression.

Resource Conservation and Development Projects

A portion of the authorized Sunflower Resource Conservation and Development Project is included in this unit. Opportunities for development within this project are discussed in the Lower Arkansas Unit narrative beginning on page 163.

Rural Water Districts

There is little need for rural water districts in this unit. Generally, there is sufficient groundwater of good quality to meet municipal, rural domestic, and livestock demands. (Exhibits 22 and 27)

Rural Electrification Administration

The discussion on page 69 also applies to the Rural Electrification Administration Program in this unit.

IMPACT OF USDA PROGRAMS

Land Treatment Measures

The discussion on page 70 also applies to the impact of land treatment in this unit.

TERRACING IS EFFECTIVE AS A FLOOD CONTROL MEASURE IN BEAR CREEK WATERSHED, STANTON COUNTY.

Upstream Watershed Projects

There are no P.L. 566 projects at present or recommended for early action in this unit.

Long Range Projects - A watershed project in Little Bear Creek subbasin may someday become economically feasible. This project could potentially benefit 6,396 acres of flood-plain land within the project area. In addition 31,019 acres below the project boundary would be benefited. Current estimates of average annual benefits and costs are:

Benefits	$126,700
Costs	$159,300
Benefit-Cost Ratio	0.80:1

Forest and Grassland Management Programs

The recommended National Grassland program of land treatment and structural measures will help reduce sediment. Revegetation of ranges, fence construction, water developments, and intensive management of livestock ranges will increase forage density and beef production.

The increased forage and reduced sediment yield, as a result of land treatment and structural measures, will enhance water quality in the Cimarron Unit.

As a result of revegetation efforts, more livestock use may be permitted. Stockman's income will be increased substantially by increased forage and beef production.

Under the proposed program, management and utilization of the national grassland resources will keep pace with population growth and national economic development needs.

Some of the other benefits are:

1. Improved watersheds, which will insure the maximum flow of usable water for downstream use.

2. Improved domestic livestock and big game ranges which will aid in stabilizing the local livestock industry and insure stable game numbers.

3. Increased public fishing and hunting opportunities.

4. Increased number of tourists which will be of economic importance to the surrounding towns and cities.

5. Increased number of people employed in harvesting timber and in recreation.

6. Increased financial revenues which will in turn increase payments to counties for school and road purposes.

The general discussion beginning on page 228 also applies to the impact of forest management programs in this unit.

Employment in the unit in timber-based industries is expected to rise from zero employees in 1965 to sixty in the year 2020. (Exhibit 42) Most of this employment will be in the manufacturing of primary timber products.

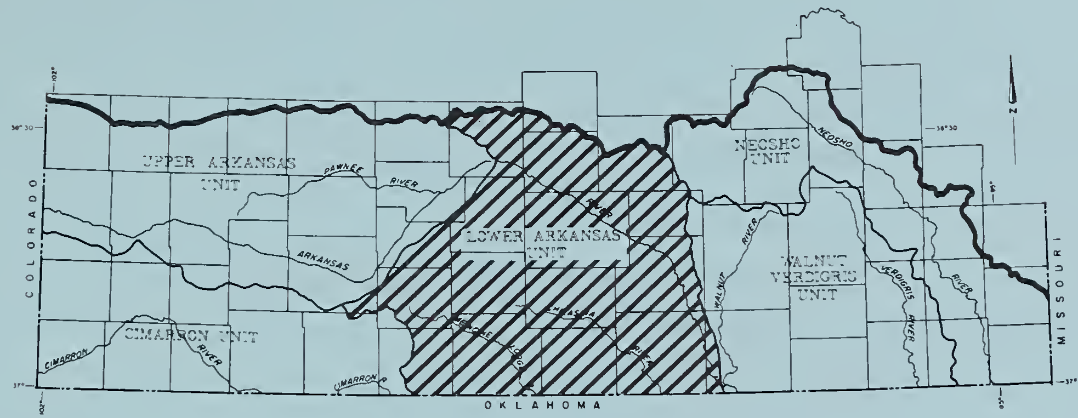
Resource Conservation and Development Projects

Impacts of the authorized Sunflower RC&D project are discussed in the Lower Arkansas Unit narrative on page 169.

Rural Water Districts

The impact of rural water districts in this unit will be small. It is anticipated that very few districts will be developed.

LOWER ARKANSAS UNIT



Land Use -	Cropland	-	4,703,020 acres
	Rangeland	-	2,085,850 acres
	Forest	-	64,260 acres
	Other	-	570,970 acres
Total Area		-	7,424,100 acres

Total Capability Class I, II, III, and IV Land - 5,796,000 acres (78%)

Irrigated Acreage - 100,000 acres (1971)

Average Annual Precipitation - 22 to 32 inches

Land treatment is adequate on 1,855,400 acres of cropland (39%) and 919,300 acres of rangeland (44%)

The total cost of applying needed crop and pasture land treatment is estimated to be $40,500,000

The total cost of applying needed forest land treatment is estimated to be $3,433,400.

Floodwater and sediment damages on tributary streams average $2,477,900 annually--some 370,600 acres are subject to inundation

P.L. 566 Watershed Projects Completed or Authorized for Construction - Three

Active P.L. 566 Watershed Projects Authorized for Planning - Two

Five feasible Early Action watershed projects are needed within the next 10-15 years

One additional watershed merits consideration for Long Range project development

Page

LOWER ARKANSAS UNIT

NATURAL RESOURCES

Location and Size

The Lower Arkansas Unit is that portion of the Arkansas River Basin in south-central Kansas bordered on the west by the Cimarron and Upper Arkansas Units and on the east by the Walnut-Verdigris Unit. (Exhibit 1) This unit includes 11,600 square miles or 7,424,106 acres which is about 28 percent of the survey area. U.S. Highway 54 extends 170 miles east-west across the unit. U.S. Highway 281 crosses the unit north-south along a 140 mile route.

The Arkansas River flows generally southeast across the unit between the cities of Great Bend and Arkansas City. Major tributaries entering the river along its course are Rattlesnake Creek, Cow Creek, Little Arkansas River, Ninnescah River, and Slate Creek. Other major streams in the unit that join the Arkansas River in Oklahoma are the Chikaskia River, Medicine Lodge River, and Salt Fork. Drainage areas by major streams are:

Name	Area in Square Miles
Direct Arkansas Tributaries	1,930
Rattlesnake Creek	1,305
Cow Creek	925
Little Arkansas River	1,357
Ninnescah River	1,311
North Fork Ninnescah River	881
Salt Fork Arkansas River	1,138
Medicine Lodge River	1,100
Chikaskia River	1,653
Total	11,600

Harper, Barber, Pratt, Kingman, and Reno are counties entirely within the Lower Arkansas Unit. Other counties partly included are Comanche, Clark, Ford, Kiowa, Edwards, Pawnee, Stafford, Barton, Rush, Ellsworth, Rice, McPherson, Marion, Harvey, Sedgwick, Sumner, and Cowley.

Climate

Climate of the Lower Arkansas Unit is subhumid continental. It is characterized by large daily and annual ranges in temperature and by hot summers and rather cold winters. Moisture laden air originating in the Gulf, hot, dry air coming from the desert southwest, and cold Arctic air masses are responsible for the changeable and sometimes spectacular weather patterns.

Average yearly precipitation ranges from 21.93 inches at Greensburg to 28.41 inches at Wichita. (Exhibit 2) Precipitation varies widely from year to year. In general, shortage of moisture limits the types of non-irrigated crops that can be grown successfully. Normally, about three-fourths of the annual precipitation falls during the six month period extending from April through September. Rainfall decreases markedly through August and September, and occasionally soil moisture is inadequate for planting of winter wheat and other fall sown crops.

In periods when rainfall is heaviest, much of it comes in showers and thunderstorms. On the average, 55 to 60 days each year have thunderstorms, a few accompanied by high winds and hail. Hail damage is usually confined to small local areas.

Snowfall is usually light. The average for central areas of the unit is about 15 inches annually. Blizzards occur occasionally but are usually of short duration. Snow usually does not remain on the ground long.

Droughts are often severe, and occasionally several successive years are drier than normal. Droughts were especially severe during the periods 1931-1940 and 1952-1957. In addition to the hazard of drought, hot burning winds affect the area.

Average annual lake evaporation ranges from 56 to 63 inches in this unit. Two years out of 100, annual lake evaporation will exceed average evaporation by 25 to 30 percent.

Records kept for the weather station near Pratt indicate average January and July temperatures of about 33 and

82 degrees respectively. Extremes in temperature range from 115 degrees recorded June 25, 1911, to -24 degrees recorded February 12, 1899. Records for other weather stations in the unit would show similar temperature patterns. The average length of frost-free period ranges from 174 days in Barton County to 192 days in Comanche County. Freezing temperatures at Pratt were recorded as late as May 25 and as early as September 20.

Surface winds are moderate to occasionally strong in all seasons. The windiest period is March and April when the average hourly wind velocity exceeds 15 miles per hour. The prevailing wind is southerly, but winter winds from the north and northwest are not uncommon. Because of the wind and dry weather, soil blowing is a hazard.

Topography

The Lower Arkansas Unit lies in six physiographic areas. The McPherson, Great Bend, and Wellington Lowland are parts of the Arkansas River Lowland division of the Central Lowland Province. The Smoky Hills, Red Hills, and High Plains are parts of the Great Plains Province.

The Arkansas River has low banks with a broad sandy bed averaging about 400 feet wide. The channel presents a braided pattern which indicates a depositing stream. The valley of the Arkansas River is five to ten miles wide.

The Great Bend Lowland is largely an undulating plain of slight relief. Much of the area is covered with sandy soils and in places low sand dunes. These areas contribute little runoff to streams.

The Little Arkansas River starts in the Smoky Hills area and flows southeastward into the McPherson and Great Bend Lowland. Most of the McPherson Lowland is a flat plain. Low sand dunes lie southwest of the Little Arkansas River in southeast Rice County and northeast Reno County.

Cow Creek also originates in the Smoky Hill area in rolling to hilly topography. The western portion of Cow Creek is a flat undulating plain containing the Cheyenne Bottoms. This most interesting topographic feature is a basin, roughly circular, comprising about sixty square miles.

Rattlesnake Creek has its source on the High Plains of Ford and Kiowa Counties. It flows northeast through flat, sandy terrain to the Arkansas River in Rice County draining most of the Great Plains Lowland. Portions of Rattlesnake basin are covered with sand dunes. Some lands have non-contributing drainage.

THESE ARE TYPICAL SAND DUNES IN THE RATTLESNAKE CREEK WATERSHED IN STAFFORD COUNTY.

The Ninnescah River is formed by the North Fork and the South Fork joining in western Sedgwick County. The North Fork originates in the lowlands of Stafford County. The South Fork starts on the High Plains of Pratt County. The upper reaches of both forks are flat, undulating plains. In the lower reaches the channels are well defined. The basin as a whole is flat to slightly rolling.

Slate Creek drains a gently rolling featureless plain almost entirely in Sumner County.

The Chikaskia River originates on the High Plains of Pratt County. It flows through a rolling prairie onto a flat valley in Sumner County. The Wellington Lowlands are more rolling than other lowland areas.

The Medicine Lodge River and the Salt Fork flow through the Red Hills of Comanche and Barber Counties. The Red Hills have rough topography including jagged escarpments, numerous small canyons, steep bluffs, and buttes. The scenic Red Hills derive their name from the exposed red Permian rock.

THE RED HILLS OF BARBER COUNTY HAVE HIGH ESCARPMENTS, CANYONS, BUTTES, AND BLUFFS.

Geology and Soils

Exposed rocks are sedimentary and range in age from Recent to late Permian. The alluvium along the streams, the sand hills of Pratt, Stafford, and Barton Counties, and a sand hill belt adjacent to the river in Rice and Harvey Counties have been deposited most recently of all the basin formations. Pleistocene wind blown silt blankets the flat to gently rolling uplands in Kiowa, Pratt, and Reno Counties, and large upland areas in the eastern counties of the unit. The four glacial stages together with the interglacial periods are represented in a mantle of sand and gravel exposed chiefly

in Reno, Kingman, and northern Harper Counties with lesser areas of exposure in other counties. The mantle rock thins to the southeast to expose older consolidated rock of Tertiary, Cretaceous, and Permian systems.

The Ogallala Formation composed of mortar beds, calcareous silt, sand, and gravel occurs as two outliers in Kingman and Reno Counties. These erosional remnants are evidence of greater areal extent of the beds in earlier times.

The Cretaceous rocks are composed of sandstones and shale of which the Dakota Formation is the most prominent. These rock formations occur in small areas in Barber, Comanche, McPherson, and Rice Counties.

The Permian rock occurs chiefly under the surface in southern counties of the unit. The formations are composed of sandstone, siltstone, and shale. The Blaine Formation contains massive gypsum beds while the Wellington Formation includes large salt deposits of economic importance.

The nearly level and gently sloping upland consists predominantly of deep, moderately well drained to well drained, clayey to loamy soils. (Exhibit 3) Most of the soils have formed from loess, plains sediments, or materials weathered from shale. In the west-central part of the unit, mostly south of the Arkansas River, is an extensive area of sandy soils. Most of the sloping soils along drainageways are deep, well drained, loamy soils. In the southern part of the unit the steep slopes have moderately deep and shallow soils over shale. Soils in the area northeast of Great Bend are affected by salt and alkali. On the bottomland the soils are loamy to sandy. Most of the soils on bottomland are deep but they range from poorly drained to well drained.

<u>Minerals</u>

Oil and gas fields are widespread over the unit. (Exhibit 4) Barton County leads the state in production of oil and gas. Stafford and Reno Counties have been among the top ten oil-producing counties. The Lower Arkansas Unit is one of the most thoroughly explored areas and future discoveries may not be extensive. Oil and gas and related products accounted for 93 percent of the total value of minerals in 1957.

Sizable gypsum deposits outcrop in parts of Comanche, Kiowa, and Barber Counties. Gypsum is currently being mined south of Sun City in Barber County. Reserves of gypsum are extensive and sufficient to meet future needs for many years.

Thick salt beds underlie the entire basin except in the eastern tier of counties. The thickness ranges up to 700 feet. Lesser amounts of salt are found above the massive, thick deposits.

Sand and gravel deposits are plentiful in practically all counties. Sand and gravel production is prevalent in the Arkansas River valley. Other workable pits are found on the tributaries and occasionally in the uplands.

Other minerals of less economic importance include an abundance of ceramic shales, scattered deposits of volcanic ash and traces of copper bearing minerals.

Land Use and Management

The Lower Arkansas Unit is within the Central Great Plains Winter Wheat and Range Region of the United States. It is divided into six major land resource areas: area 73, The Rolling Plains and Breaks; area 74, Central Kansas Sandstone Hills; area 75, the Central Loess Plains; area 78, the Central Rolling Red Plains; area 79, the Great Bend Sand Plains; and area 80, the Central Rolling Red Prairies. (Exhibit 5)

Land use for each land resource area in the Lower Arkansas Unit is as follows:

Land Resource Area	Cropland		Rangeland		Forest		Other		Total Acres
	Acres	%	Acres	%	Acres	%	Acres	%	
073	115,718	77	32,361	22	--	-	1,706	1	149,785
074	34,600	76	6,493	14	--	-	4,497	10	45,590
075	1,402,076	75	238,785	13	30,267	2	182,163	10	1,853,291
078	331,048	30	749,185	67	8,740	<1	29,718	3	1,118,691
079	1,127,600	69	400,381	25	6,169	<1	91,960	6	1,626,110
080	1,691,976	64	658,652	25	19,086	1	260,925	10	2,630,639
Total	4,703,018	63	2,085,857	28	64,262	1	570,969	8	7,424,106

Land use of the Lower Arkansas Unit by land capability class is shown in the following table:

Land Capability Class	Acres by Land Use				Total
	Cropland	Rangeland	Forest	Other	
I	706,701	52,003	6,190	79,845	844,739
II	2,214,193	328,883	3,107	197,662	2,743,845
III	1,271,378	285,243	4,752	117,660	1,679,033
IV	347,195	150,193	2,914	28,072	528,374
V	13,095	134,363	10,045	4,566	162,069
VI	149,337	1,007,932	14,737	63,116	1,235,122
VII	1,119	127,240	22,517	80,048	230,924
VIII	0	0	0	0	0
Total	4,703,018	2,085,857	64,262	570,969	7,424,106

Two percent of the unit lies in land resource area 73. Nearly all of this land is in farms and ranches. Seventy-seven percent of the area is cropland. Winter wheat is the main cash crop. Grain sorghum is the only other crop utilizing any large acreage.

Rangeland occupies 22 percent of land resource area 73 within the unit. On the hardland areas, shortgrasses such as buffalograss and blue grama are predominant species. During periods when moisture conditions are favorable, increases in midgrasses, mainly western wheatgrass and sideoats grama, may occur. Sideoats grama, blue grama, and little bluestem are the predominant grasses found in the breaks area. Tall and midgrasses occupy the sandy range sites. Sand and little bluestem, sand lovegrass, and switchgrass are common to these areas.

Cities and towns, roads, highways, railroads, water areas, and other non-agricultural land uses account for one percent of land resource area 73.

Land capability classes within land resource area 73 range from I through VI. Seventy-eight percent of the area is classified as I, II, III, or IV of which 85 percent is cropland.

The extreme northeast portion of the unit lies in land resource area 74, the Central Kansas Sandstone Hills. Only 1 percent of the unit is accounted for in this land resource area. Land use consists of 76 percent cropland, 14 percent rangeland, and 10 percent other. Wheat and grain sorghum are the major dryland crops.

Those grasses mentioned for land resource area 73 would predominate in this area also.

Cities and towns, roads, railroads, water areas, etc. make up the ten percent of land cataloged as other in land resource area 74.

Land capability classes II through VI can be found in the Central Kansas Sandstone Hills area of the unit. Nearly 60 percent of this area is classified as land capability class II of which 83 percent is cropland.

The eastern area of the unit is within land resource area 75, the Central Loess Plains. Approximately 25 percent of the unit lies within this resource area. Rangeland occupies 13 percent of the area. Those native grasses found in land resource areas 73 and 74 are the major species found in this area. Cropland represents about 75 percent of the total area. Wheat, grain sorghum, and alfalfa occupy the major portion of the cropland area. Only 1 percent of the cropland is irrigated. Corn and grain sorghum utilize most of the irrigated acreage.

The remaining land in resource area 75 is utilized for non-agricultural purposes.

Land capability classes I through VII can be found in the Central Loess Plains area. Ninety percent of this area is classified as class I, II, III, or IV of which 82 percent is cropland.

The southwest portion of the unit lies in land resource area 78, the Central Rolling Red Plains. Fifteen percent of the unit is in this area. Rangeland is the major land use, occupying 67 percent of the area. Those grasses listed by sites in the other land resource areas predominate in area 78 also. Cropland accounts for 30 percent of the total area. Land use in the cropland area is mainly wheat, grain sorghum, and alfalfa. Other land uses, not directly associated with agriculture, make up the remaining area.

Land resource area 78 has land in capability classes I through VII. Nearly 50 percent of this land resource area is in land capability class VI of which 92 percent is used for grazing.

Land resource area 79, the Great Bend Sand Plains, is located in the northwest part of the Lower Arkansas Unit and accounts for 22 percent of the total area. Sixty-nine percent of the area is cropland, 25 percent rangeland, and 6 percent other uses. One percent of the cropland area is irrigated. Wheat, grain sorghum, and alfalfa are the principal dryland crops and corn and grain sorghum the principal irrigated crops. Rangeland vegetation consists of those species of native grass found in all other areas of Lower Arkansas Unit.

Land capability classes within land resource area 79 range from I through VII. Capability classes I through IV

account for 84 percent of the total area. Eighty-one percent of this is utilized for crop production.

Thirty-five percent of the unit is in land resource area 80, the Central Rolling Red Prairies. Sixty-four percent of the area is devoted to crop production, mainly wheat, grain sorghum, and alfalfa. Rangeland comprises 25 percent of the area. Native grass species are those mentioned in other areas. Forest accounts for about 1 percent of the area. Other uses account for 10 percent.

Land capability classes I through VII exist within land resource area 80. Classes I through IV account for 82 percent of all land in the unit and 77 percent of this is cropland.

Water Resources

Surface Water - Generally adequate information is available about streamflow characteristics in the unit. In 1970 the U.S. Geological Survey reports a total of 20 continuous record stream gaging stations in operation, 4 on the Arkansas River mainstem and 16 on tributary streams. Only 5 of the tributary gages have record lengths exceeding 15 years. Most of the other tributary gages were installed during the period 1959-1965. The longest continuous record is that of the Little Arkansas River gage at Valley Center dating back to 1922.

Twenty-two partial record stations (mostly crest stage indicators) are also in operation within the unit. Most of these gages have been installed since 1959.

Average annual runoff across the unit varies much more than does precipitation. (Exhibit 6) The average annual runoff ranges from 4.0 inches in the east (12.5 percent of the precipitation) to 0.6 inch in the west (2.7 percent of the precipitation). This comparison shows average annual runoff to drop off nearly 5 times faster than average precipitation from east to west across the unit.

The greatest range in annual runoff reflected in records kept on tributary streams is for the Little Arkansas River at Valley Center where runoff in 1951 was almost 70 times the minimum runoff in 1956. Maximum annual runoff in 1951 on the South Fork Ninnescah River near

Murdock, on the other hand, was only 5 times greater than the minimum runoff in 1956. Daily discharges fluctuate considerably more than annual runoff. For instance, extreme daily discharges at the Little Arkansas River, Valley Center gage, range from a high of 25,100 cfs in 1945 to a low of 1.2 cfs in 1956. Two of the tributary stations have experienced complete flow stoppage.

Tributary streams of the Lower Arkansas Unit have experienced many floods in the past half century. Floods have occurred in practically all months of the year, but most frequently in May, June, and July.

Hydrologic studies reveal that the 100 year frequency flood event probably has not occurred during the period of stream gaging on several of the tributary streams. (Exhibit 7)

Most of the water quality data collection now underway in this unit is of recent origin. (Exhibit 6) Information as to the chemical quality of surface water is being obtained by the Kansas State Board of Health at 10 of the permanent stream gaging stations and also at three sites where data are collected on chemical quality only. Sediment data is collected at eight locations.

The chemical content of some streams in the unit is subject to considerable fluctuation. It is difficult to generalize about the overall quality of streams. Nevertheless, on the basis of available information, it appears that the Arkansas River water is generally poor at Great Bend and fair at Arkansas City; the Ninnescah River is generally good along the North Fork and the mainstem and fair along the South Fork; the Little Arkansas River water is generally good; Cow Creek is fair; Rattlesnake Creek is generally poor; and the Chikaskia River is excellent at the Corbin gage near the Kansas-Oklahoma state line. Little information is available regarding the quality of water in the other streams. Indications are that the Medicine Lodge and Salt Fork waters are poor and that Slate Creek waters range from fair to poor with the quality debased by contributions of poor quality spring water near Geuda Springs.

The total dissolved solids in the rivers and streams of the unit have at times reached levels much higher than the U.S. Public Health Service's recommended desirable upper

limit for drinking water purposes of 500 parts per million (ppm). The same is true for the two dissolved solids of greatest significance in this unit -- chlorides and sulfates. The desirable upper limit for each of these constituents, as recommended by the U.S. Public Health Service, is 250 ppm. The sulfates and chlorides present in water supplies are mostly from natural sources, that is, the natural leaching of soils and salt formations. However, man has also played a part in adding chlorides and some sulfates to water supplies through such activities as oil production, salt mining, irrigation, and other industrial activities.

The sulfate content in the Arkansas River decreases from Great Bend to Arkansas City but is still above the desirable limit at times even at Arkansas City. Most of the sulfates in the Arkansas River continue to come from west of Great Bend. None of the major tributaries in the unit carry a high sulfate load.

Except for the Arkansas River at Great Bend and the Chikaskia River, the mainstem and the principal tributaries are generally high in chlorides. Rattlesnake Creek drains an area of sand hills and salt marshes and the chloride content is generally quite high as the creek enters the Arkansas River. For a number of years, considerable quantities of salt brine were added to the Arkansas River as a result of operation of the salt mines near Hutchinson. Brine pollution from this source is now being reduced. However, contributions of chlorides from Rattlesnake Creek and Cow Creek continue to affect the quality of the mainstem downstream.

The flows of the Little Arkansas River are affected by what appear to be oil field brines, particularly from the Sand Creek area in southeast Rice County and the Turkey Creek area of southern McPherson County. While direct pollution of surface waters as a result of disposal of oil field brines in surface ponds has largely ceased, some of the groundwater in this area has become polluted. The polluted groundwater continues to seep into the streams. As this groundwater is flushed out over the years, the quality of water in these streams should improve. At higher river stages, the quality of the Little Arkansas River water is generally good. In the sampling period 1956-59, there were times when total dissolved solids

reached levels above the U.S. Public Health Service's recommended limit. Sulfates were well below the limit. Chlorides ranged from 45 to 385 ppm.

While the quality of the water in the North Fork Ninnescah and the Ninnescah mainstem is generally good, the South Fork is fairly high in chlorides which are picked up after the river passes Pratt. Recent investigations suggest that the brines originate at a point upstream from Kingman, possibly from artesian sources.

Because of the wide diversity of soils, topography, and land use, this unit probably has as wide a range of sediment size and rates as any unit in Kansas. Arranged in order of weighted sediment discharge concentration, Cow Creek and the Little Arkansas are lowest in the unit with average rates of from 900 to 1,800 ppm. The Arkansas River and Ninnescah follow with average sediment rates of around 1,200 to 3,000 ppm. The suspended material transported by these streams is predominantly clay with 10 to 15 percent silt. Bed load is mostly sand with a small percentage of coarser material. The average sediment load transported by the Medicine Lodge and Salt Fork Rivers is about 7,000 to 15,000 ppm with extremes as high as 26,000 ppm.

Groundwater - The subsurface formations within the Lower Arkansas Unit are generally good sources of groundwater. (Exhibit 22) The quantity and quality of the water is closely related to the geologic characteristics of the water bearing formation. The Permian formations exposed in the lower one-third of the unit are a relatively poor source of groundwater. This is also true of the Cretaceous system except in the northern part of the Lower Arkansas River valley where the Dakota formation is a source of supply.

Much of the groundwater of the basin is of relatively good quality. The best source of groundwater is the thick mantle of sands and gravels in the Arkansas River valley and adjacent areas. The most important groundwater area is a portion of Harvey, Sedgwick, Reno, and McPherson Counties known as the Equus Beds. Large quantities of groundwater are also available in northern Pratt, northern Kiowa, Stafford, and southeast Edwards Counties.

Oil field brines and leaching from salt mine operations add minerals to adjacent groundwater.

Wells taking water from shallow Pleistocene deposits are generally satisfactory in quality. Water from the Ogallala formation is generally of good quality throughout the unit. Water from shale, limestone, and sandstone is generally of fair to poor quality.

Fish and Wildlife Resources

Fishing opportunity in the Lower Arkansas Unit is found in numerous streams and lakes. Fishing in the streams can be classified as fair to good. General limitations include low stream levels and access. Anglers can usually obtain permission by asking landowners. Channel catfish, bullheads, and carp are the dominant species utilized by fishermen in these streams. (Exhibit 9)

There are a number of impoundments in the unit. (Exhibit 8) In addition to the larger impoundments, in 1967 there were approximately 7,067 farm ponds in the Lower Arkansas Unit. This is an average of 1 pond for every 1,120 acres.

Wildlife of the Lower Arkansas Unit is influenced by the subhumid and continental type climate of the area. Timber and brushy areas along stream channels provide habitat for populations of whitetail deer and Rio Grande turkey. (Exhibit 10) These populations are increasing within this unit. A herd of antelope reside in the rough sandhill-sagebrush area of the southwestern part of the unit. This area in Comanche and Barber Counties also provides habitat for lesser prairie chicken. Upland game bird populations vary greatly across the unit because of difference in climate and farm practices.

Game animals utilizing the unit include whitetail and mule deer, pheasant, bobwhite and scaled quail, dove, cottontail and jackrabbit, fox squirrel, and waterfowl. Deer are the only big game species harvested in the Lower Arkansas Unit. Populations of Rio Grande turkey are increasing. A limited turkey season is anticipated in the near future.

WILD TURKEYS IN BARBER COUNTY.

The Lower Arkansas Unit is located within the Central Flyway and numerous species of waterfowl pass through the area during spring and fall migration. Two refuge areas (Cheyenne Bottoms Waterfowl Management Area and Quivira National Wildlife Refuge) and Cheney Reservoir receive heavy use by migrating waterfowl. Biologists of the Forestry, Fish and Game Commission estimated the duck use-weeks at the three areas for the period August 1, 1967, to April 30, 1968, to be 5,078,000. The goose use-weeks at the three areas for the same period was estimated to be 456,800.

Three major overwintering areas for crows are located within the Lower Arkansas Unit. The largest near Medora in Reno County has been estimated to contain in excess of one million crows annually. The other two sites are located near Radium in Stafford County and near Rago in Kingman County. Flocks at these sites are not as large as the Medora flock. Estimates place the Rago flock at approximately 300,000 birds and the Radium flock near 100,000 birds. During more severe winters the Radium flock may move to the Rago site if a food shortage develops.

Species which provide varmint hunting in the Lower Arkansas Unit are black-tailed prairie dog, coyote, and black-tailed jackrabbit.

The more predominant furbearers of this area include mink, muskrat, beaver, raccoon, and coyote. Populations of red and swift fox are also present.

Forest Resources

Woodlands of the Lower Arkansas Unit, primarily hardwoods, are composed of elm-ash-cottonwood, bur oak, hackberry, willow and black walnut. (Exhibit 13) The woodlands contain many cull or undesirable trees and other vegetation and need forest management. These woodlands are important to the local economy and will increase in future importance for timber production and recreation.

The natural woodlands are found primarily along stream bottoms, side drainages and adjacent slopes. They become scarcer and more closely confined to the stream banks in the western part of the unit.

Commercial woodlands cover only 58,462 acres (less than 1 percent) of the land in the unit. All of the commercial forest land is privately owned. (Exhibit 11) Noncommercial forest land, or land incapable of yielding a merchantable timber crop, covers 5,800 acres. These woodlands are found primarily on the poorer upland sites characterized by shallow, rocky soils.

The expected increase in population by 2020 will result in the withdrawal of a small percentage of forest land. Reforestation will probably offset losses due to anticipated urban expansion, reservoirs, agriculture, private recreational development, roads, powerlines, etc.

Sawtimber volumes total nearly 108 million board feet measured by the International 1/4-inch rule, while growing stock contains about 72 million cubic feet. (Exhibit 14) About 22 million cubic feet of growing stock volume is in poletimber-size trees. Of the sawtimber volume, 54 percent

is cottonwood, 17 percent elm, 13 percent oak, 6 percent hackberry, and 6 percent ash. The remaining 4 percent includes black walnut, willow, soft maple, other soft and hard hardwoods. (Exhibit 13) The average sawtimber volume per acre of sawtimber is approximately 3,000 board feet.

Poor markets (until recently) and relatively light cutting have resulted in timber of large diameter classes. Therefore, about 2/3 to 3/4 of the sawtimber volume is in large trees 19 inches and over in diameter. The unit's sawtimber, especially cottonwood, elm, hackberry, and black walnut, is exceptionally high in quality.

Net annual growth of sawtimber on commercial forest land is approximately 3 million board feet, or about 84 board feet per acre. (Exhibit 43) This relatively low current annual growth is due in part to past cutting practices, fires, and grazing. A large amount of growing space is now used by poor trees, brush, or other vegetation that restricts growth of desirable trees.

Timber cut in 1964 was very low amounting to about 3,000 board feet per acre. For maximum growth timber volume per acre should be 2 to 3 times greater. The sawtimber cut on commercial forest land amounted to about 1 million board feet as compared to an annual growth of 3 million board feet. Cottonwood was the most heavily cut species.

The sawtimber cut in the unit is expected to rise to 2 million board feet in 2020. (Exhibit 43) The sawtimber inventory is estimated to remain about the same during this period.

In 1964, some 760 people were employed in the timber-based industries in the Lower Arkansas Unit. These estimates include timber harvesting and manufacturing of timber products. They do not include employment in forest management, protection, or secondary manufacturing of timber products. Eight wood-using plants were operating in the unit in 1964. In addition to the 6 sawmills, there were 1 charcoal plant and 1 fence-post yard and treating plant.

Quality of Natural Environment

Early settlers did not find a friendly environment when they came to this area. There were no trees to break the winter winds rush. Life was a constant struggle as it had been for the Indians before them. Many returned east with frightening stories about this treeless grassland and discouraged others from making the venture westward. Some of these stories persist today.

Those that stayed set about making this new home look more like the home they left behind. Trees were planted and now grow in abundance along streams and as field borders. The present day landscape has a variety of interesting vegetative growth. The trees, shrubs, wildflowers, grasses, and grains add a magnificence to the landscape especially in the spring and fall. Most streams flow perennially in a thin sheet of clear water over their sandy beds. The weather is still sometimes an awesome thing but natives have learned to adapt and long for its changeable nature when forced to be away for any great period of time. Everyone is proud of the many clear, sunfilled days when the natural beauty about them is in full uninterrupted view.

The early settlers established many towns, few of which grew to large size. Many of them are now just names on old maps. Most of the remaining towns range in population from 300 to 1,000 and offer friendly community life without major water and air pollution problems. The largest cities of the unit such as Hutchinson, McPherson, Pratt, Newton, Wichita, and Wellington have broad, tree-lined streets with well kept parks and a hint of small town atmosphere that many people find comforting.

Topography of the unit varies from flat almost featureless plains to rolling uplands and steep bluffs. Many people find inspiration in broad open expanse with a relatively uninterrupted view. Others enjoy the variable background offered by the hills and canyons of Barber County.

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

Watershed Protection and Management

Erosion and Sediment Damage - Wind is as important as water in causing soil erosion in the Lower Arkansas Unit. The more sandy soils of the Arkansas River Lowlands are subject to severe wind erosion. The High Plains may have moderate to severe soil blowing. Wind erosion is slight over the remainder of the basin.

The sandy lowlands absorb a high percent of the rainfall with little runoff. Erosion from runoff is slight.

The Red Hills with rolling topography and silty to clayey soils and low permeability are subjected to severe sheet and gully erosion. In other parts of the unit sheet erosion may be moderate with minor gullies.

The project approach to grade stabilization is not needed in this unit. Land stabilization problems generally can be solved through individual action with on-farm land treatment measures.

Sediment yields in the Lower Arkansas Unit were estimated from sediment surveys on ponds with watersheds of one to five square miles of drainage area. They show annual yields that vary from slight to over 1.5 acre feet per square mile. The rate of yield is principally dependent on amount of rainfall, soil permeability, and type of topography. Sandy soils on flat land on the west side of the unit may yield a fraction of the sediment produced from sloping silty clay land with greater rainfall on the east side.

The Arkansas River Lowlands in Stafford, Reno, Rice, and Sedgwick Counties and the extension of the High Plains in Kiowa and Pratt Counties may yield up to 0.5 acre feet of sediment per square mile per year. The Wellington and McPherson Lowlands may produce sediment at an annual rate of 0.25-0.75 acre feet per square mile. The rate for average farmland in the Smoky Hills of Rice County may be 0.75-1.25. The rugged Red Hills of Barber, Harper, and Kingman Counties with very erosive soil may yield in excess of 1.50 acre feet per square mile per year. (Exhibit 16)

Sediment is deposited in ponds and reservoirs causing a reduction in capacity. Infertile sands when deposited on the Arkansas River floodplain and along other sandy streams may cause severe soil damage. Deposition of fine textured sediments on bottomland causes slight damage.

Land Treatment Needs - Current conservation treatment adequately meets the conservation problems on 41 percent of the 115,718 acres of cropland in land resource area 73. (Exhibit 17) Residue management, mainly stubble mulching, stripcropping, and terracing, are the principal dryland land treatment practices needed.

Treatment is adequate on 86 percent of the rangeland in land resource area 73. Proper grazing use is the only practice needed.

The land treatment problems have been adequately solved on 19 percent of the cropland acres in land resource area 74. Stripcropping, terracing, and stubble mulching are the most needed land treatment practices. Ten percent of the cropland still needs stubble mulching and 71 percent of the area needs stripcropping and terracing.

Only 11 percent of the rangeland in land resource area 74 has been adequately treated. Proper grazing use is needed on 5,798 acres.

Land treatment measures have adequately solved the conservation problems on 43 percent of the cropland acres within land resource area 75. The application of terracing, stripcropping, and residue management will provide adequate treatment for over one-half of the area. Permanent cover should be established on 5,608 acres presently being cropped. Drainage is needed on 4 percent of the cropland area to improve surface drainage and provide for more effective utilization of rainfall. To accomplish efficient use of irrigation water according to the moisture needs of the crop, irrigation water management needs to be practiced on 4,206 acres.

Twenty-six percent of the rangeland in land resource area 75 is adequately treated. To be adequately treated, proper grazing use needs to be practiced on 67 percent of the rangeland. Six percent of the rangeland requires seeding before it can be used to its capacity.

SEVERE CROPLAND EROSION IN CENTRAL LOESS PLAINS (LAND RESOURCE AREA 75) IN HARVEY COUNTY.

In land resource area 78, a total of 138,047 out of 331,048 acres of cropland have been adequately treated. Stubble mulching, stripcropping, and terracing will solve the conservation problems on 118,515 acres. Permanent cover should be established on 18,870 acres presently being cropped.

Over two-thirds of the rangeland in land resource area 78 have been adequately treated. Proper grazing use is required on 27 percent of the rangeland. Brush control is needed on 23,498 acres.

Land treatment adequately meets the needs on 30 percent of the cropland acres in land resource area 79. Residue management is needed on 31 percent of the cropland area and stripcropping and terracing on 28 percent. Permanent cover needs to be established on 11,276 acres. Drainage is needed on 9 percent of the cropland area. More efficient application of water through planned irrigation systems is needed on 10,148 acres.

Thirty-eight percent of the rangeland in land resource area 79 has received adequate treatment. Proper grazing use

is needed on 52 percent of the rangeland acres. To be adequately treated, brush control should be applied on 3 percent of the area and range seeding on 6 percent.

Treatment is adequate on 38 percent of the cropland in land resource area 80. To adequately treat the remaining area, residue management is needed on 14 percent, terracing on 44 percent, contour farming on 3 percent, and permanent cover established on 1 percent of the area.

Twenty-three percent of the rangeland in resource area 80 has received adequate treatment. Proper grazing use is required to improve 66 percent of the rangeland. Four percent of the area needs brush control, 5 percent needs range seeding, and 1 percent needs to be improved for more efficient and uniform grazing through planned grazing systems.

The general discussion (beginning on page 38) about the physical need for particular land treatment measures also applies to the need for residue management, stripcropping, terracing, planned irrigation systems, proper grazing use, range seeding, and brush control in this unit.

Woodlands - The general discussion beginning on page 192. also applies to the watershed protection and management needs of woodlands in this unit. These needs are quantified on page 163.

<u>Floodwater and Sediment Damages</u>

Floodplain damages discussed herein are those occurring on tributary streams of the unit. Mainstem Arkansas River flood damages were not evaluated except where identifiable in the immediate vicinity of a tributary outlet. (Exhibit 18a)

Streams entering the Arkansas River above Wichita do not contribute significantly to floods on the mainstem Arkansas. These streams are characterized by wide, flat floodplains that attenuate peak flows severely by a combination of large valley storage and highly permeable floodplain soils. Streams flowing into the Arkansas below Wichita are known to be significant contributors to mainstem flooding. Past flood flows in both the North and South Forks of the Ninnescah River have been high in relation to their drainage area. Slate Creek also produces high peaks in relation to its drainage area size.

Of the four major southern tributaries that cross into Oklahoma, the Chikaskia River and Bluff Creek are subject to the greatest overflows. Both streams flow through a region of tight, heavy soils which produce rapid and large quantities of runoff during intense storms. A high percentage of grassland is found on floodplains of these streams. The Medicine Lodge and Salt Fork Rivers originate in high, rolling, prairie and flow through the Red Hills where soils have low permeability rates that are conducive to rapid runoff.

Agricultural areas suffer the greatest flood damage. An estimated 370,624 acres along tributary streams are subject to inundation by a 100-year frequency flood (a flood which has a one percent chance of occurring in any given year). Some 195,838 acres of cropland, 164,372 acres of pasture, 889 acres of urban, and 9,525 acres of miscellaneous use (including channel and adjoining timber) would be inundated by this size flood. (Exhibit 18) 4,300 acres of the cropland are currently being irrigated. Estimates of irrigation potential on these floodplain lands reach 12,000 acres.

Average annual crop damages based on 1980 projections of land use are estimated to be $1,310,000.

Other agricultural damages average $344,600 annually within this unit. Other agricultural damage includes flood damage to stored grain and hay, fences, farm buildings, and farm machinery. Also included as other agricultural damage in this unit is damage to land that has been leveled for irrigation. This item would reflect re-leveling costs and costs of cleaning out and repairing ditches and head structures. Cleanup of debris on agricultural lands connected with Quivira National Wildlife Refuge averages $100 annually. Floodplain scour and sediment damages are estimated to average $31,500 annually. Such damages occur on about 4,568 acres of floodplain lands. Total agricultural damages are $1,686,200 on an average annual basis.

Non-agricultural floodwater damage includes damage to roads, bridges, railroads, oil fields, and urban areas. Road and bridge damage is the major item in this category averaging $490,000 annually in the evaluated floodplains. Road and bridge damage occurring at crossings of upland draws and gullies was not evaluated but probably total more than that occurring along floodplains.

FLOODING IN HARVEY COUNTY.

Photo by: Harvey County Soil Conservation District

Railroad damage is relatively minor in the evaluated area. Twenty-two miles are damaged to the extent of $10,000 on an average annual basis. Oil field damage is also minor totaling $14,900.

Urban floodwater damage totaling $28,700 was evaluated in the following towns: Mount Hope, Andale, Wichita suburb (The Dell), Wellington, Hoisington, McPherson, Moundridge, Sedgwick, Newton, Halstead, Pratt, Kingman, Wilmore, Medicine Lodge, and Caldwell. Damages by flooding were primarily interruption of business, cleanup of sediment and debris, and loss in valuation of property.

Total average annual non-agricultural damages are estimated to be $543,600.

Indirect damage is estimated to average $248,100 annually. Indirect losses include interruption of transportation and utilities and loss of business to those serving agricultural communities.

Total evaluated tributary floodplain damages, including agricultural, non-agricultural, and indirect losses are estimated to average $2,477,900 annually.

Agricultural Water Management

Drainage - Major drainage problem areas in the unit are: the sand hills along both sides of the Arkansas River from Great Bend to Wichita; the sandy undulating lands in the upper reaches of Peace Creek and the Ninnescahs; and the depressional area of the lower Little Arkansas River subbasin. Approximately 185,000 acres are included as having impaired drainage or naturally high water table. About 151,000 acres of the problem area is presently in cropland. The drainage problem in this area is beyond the scope of individual action for solution and will require a project approach.

Impaired drainage on about two-thirds of the problem area is the result of surface water concentration in low areas having no well-defined stream channels or outlets. The groundwater table underlying these poorly drained areas usually plays an important part in the problem. To illustrate, the sandy soils of northern Stafford County allow ready recharge of the groundwater supply through precipitation. In a period of above normal precipitation the water table may rise above the land surface causing discharge from the groundwater into low areas. This condition created a temporary "mystery river" around Seward in Stafford County in the late 1950's. New irrigation development in Stafford County has pointed out a serious problem to be faced if uncoordinated development continues. Land leveling erases the low areas or "pot holes" that serve as natural storage basins for surface runoff. Natural runoff is forced to seek new ponding areas and excessive flooding of some lands occur. Irrigation tailwater adds to this problem. Defined channels for removal of problem water do not exist.

Other drainage problems are caused by: natural levees along stream banks impeding surface runoff flow into streams; natural levees being overtopped by flood flows leaving waters trapped on floodplains; and sinks or depressions formed as a result of dissolving of underground salt deposits, their removal as brine, and consequent collapse of overburden. One third of the total drainage problems falls into these categories.

Irrigation Demands - Irrigation is not yet as important in this unit as it is in the two western units. This is primarily due to the higher rainfall which normally ranges from 22 to 32 inches across the unit and lower evapotranspiration rates. There is still a need for irrigation during most years. (Exhibit 45)

The potential for irrigation growth in the Lower Arkansas Unit is tremendous. This unit has large supplies of underground water and a considerable amount of suitable land. (Exhibit 20) It also has a great deal more natural recharge than the units further west. Consequently, a large increase in irrigated acreage and in irrigation water demand is forecast for much of the unit, particularly in the northwest counties which have the most suitable land and water. (Exhibits 19, 26, and 31) At the present time, irrigation uses less water than municipal and industrial uses but is expected to demand more than twice as much by the year 2020. (Exhibit 19)

Groundwater Depletion - Almost all of the water for irrigation will come from underground supplies. (Exhibit 21) There are a few surface water irrigation rights, but usually the surface water supply is inadequate when the need for irrigation water is critical. It is estimated that the total withdrawals from groundwater will not exceed natural recharge until around the year 2000. (Exhibit 19) Even after that the draft on the underground storage will be slight. (Exhibit 23) It is not expected that water quantity will be a problem within the next 50 years. However, there are a number of areas where water quality could become a problem if precautions are not taken. There is a need for wise management of the aquifers to insure that water of poor quality from the deeper aquifers does not pollute the overlying fresh water aquifers. Oil field brines have in the past, and are presently encroaching upon some good water supplies.

Rural Domestic and Livestock Water - At the present time the livestock water demands are generally slightly more than the rural domestic demands. They are expected to increase rapidly in the future while the rural domestic demands generally decrease. (Exhibits 26 and 31) In Sedgwick County the rural domestic demands will be greater than livestock demands because of the large rural non-farm

population due to the influence of Wichita. The rural population density in the unit ranges from quite sparse in the western portion to quite heavy in the Wichita-Hutchinson area. (Exhibit 27)

The general discussion beginning on page 44 also applies to the livestock water needs in this unit. (Exhibit 28)

Generally, there is an adequate groundwater supply except along the southern tier of counties. (Exhibit 22) Quality problems are more widespread, particularly with excessive chlorides. There will be a need for more rural water districts to satisfy rural household and livestock demands.

Non-Agricultural Water Management

Municipal and Industrial Water Needs - Municipal and industrial water needs are and will be quite large in the metropolitan areas of Sedgwick, Reno, and Barton Counties. (Exhibits 19, 26, and 31) Most of the municipal and industrial water supplies come from groundwater. (Exhibit 27) There is generally an adequate supply of groundwater within feasible pumping distance of most cities. There may be some problems with inadequate quantity and poor quality in the southern tier of counties and with excessive chlorides along the mainstem of the Arkansas River. (Exhibit 22)

The industrial demands include mining, manufacturing and utilities. Utilities consist of electric, gas, and sanitary services. The mining industry is mostly petroleum and natural gas production. Considerable reduction in the production of oil and natural gas is expected over the next 50 years, but other mining--primarily sand and gravels and other non-metallic production--will offset this reduction. Although these industries have sizeable water demands, the groundwater supplies will generally be adequate. There may be quality problems in some areas which will require additional water treatment. It can be expected that more and more of the industries will obtain their water from municipalities.

Recreation - The recreation water needs were based on present and estimated future population in each county. Comparing supply to the demand for recreation within a single county may indicate a considerable deficit or surplus for that county. (Exhibit 29) However, adjoining counties may

have surpluses or deficits which balance out the totals over a multi-county area. For example, Rice County shows a deficit for boating at the present time, but adjoining Reno County shows a surplus in boating supply because of Cheney Reservoir. (Exhibit 8)

Distribution of boating water throughout the unit is a problem. There is enough boating water available for the total unit mostly because of Cheney Reservoir. However, it is doubtful that the boating demands of Kiowa, Comanche, and Barber Counties are adequately met by Cheney. Boating in the state lakes in Kiowa and Barber Counties is limited to fishing only. Fishing needs are adequately met until after the year 2000. (Exhibit 30) The present supply of swimming water will meet the demands of the unit until 1980. The large surplus of present swimming supply in Harvey and Sedgwick Counties can be attributed mostly to swimming beaches at sand pits. The quality of some of these swimming facilities could undoubtedly be improved.

Fish and Wildlife - The general discussion beginning on page 47 also applies to the fish and wildlife problems in this unit.

<u>Pollution</u>

Some streams in the unit have excessive chlorides, sulfates, and total dissolved solids from natural causes. (Exhibit 6) In some cases it may be possible to divert streamflows around these areas of natural pollution or to dilute these flows with water of better quality from reservoir storage.

There are some areas where formations of salt or gypsum cause excessive amounts of chlorides or sulfates in the groundwater. (Exhibit 22) Care must be taken in utilization of groundwater to prevent salt water from deeper formations from polluting overlying fresh water aquifers.

The return flows from irrigation are always higher in dissolved minerals than the water which was applied to the field. Return flows also may carry considerable amounts of pesticides, herbicides, and fertilizer. Irrigation return flows are not a problem in this unit at the present time. However,

with increasing irrigation it may be that irrigation return flows could adversely affect streamflow for downstream uses.

Other general discussion beginning on page 48 applies to pollution problems in this unit. (Exhibits 19, 28, 31, and 32)

Range and Forest Fires

Following are the number of fires and acres burned by major cause for the five-year period 1963-1967 for protected state and private land in the Lower Arkansas Unit:

Item	Year					5 Yr.
	1963	1964	1965	1966	1967	Ave.
No. of lightning-caused fires	0	4	9	16	24	11
No. of man-caused fires	1	99	143	565	415	245
Area burned1/ - acres	290	7,790	3,530	34,386	48,667	18,933

1/ Includes organized rural fire districts only

A general discussion of the basin-wide range and forest fire problem is included in the Walnut-Verdigris Unit narrative beginning on page 199.

Impairment of Natural Beauty

Lack of conservation practices on easily eroded cropland is probably the most noticeable water-related problem in this unit. Sumner, Harper, Barber, Barton, and Rice Counties contain examples of cropland erosion that are very unpleasant to the eye. Severe sheet and gully erosion have reduced the productive capacity of these lands. Crop foliage is generally sparse. The combination of gullies and sparse vegetation is a picture unlike that intended by nature.

Natural beauty is noticeably affected by other water problems including: droughts which cause vegetation to brown and thin out and dust to blow; floods which carry sediment and debris and drown vegetation; and water carried pollution from agricultural, municipal, and industrial sources.

LOWER ARKANSAS UNIT

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Land Treatment

The general discussion beginning on page 53 also applies to programs for accomplishing land treatment in this unit.

In the Lower Arkansas Unit, the first soil conservation district was organized in Pawnee County in January 1940 and the last in Kingman County in March 1950. To date, 38 percent of the total cropland acres and 47 percent of the total rangeland acres have been adequately treated.

Upstream Watershed Projects

The general discussion beginning on page 53 also applies to watershed program provisions in this unit.

Four watershed work plans have been completed and approved for installation.* (Exhibits 34 and 35) These projects include an area of 73,639 acres. The Spring Creek plan calls for seven floodwater retarding structures having an aggregate capacity of 4,213 acre feet. Three of these structures have been built. The Andale plan has a total of four floodwater retarding structures and two floodways. Total storage capacity is 2,502 acre feet. One structure and both floodways have been constructed. Construction is not yet underway in the recently authorized Mt. Hope and Hargis Creek Watersheds. The Mt. Hope plan includes four floodwater retarding structures (total capacity - 3,643 acre feet) and 6.53 miles of channel improvement. Hargis Creek Watershed includes 6,300 acres in Sumner County. The one structure Hargis Creek plan includes storage of 442 acre feet for sediment and 2,055 acre feet for floodwater detention.

With planned land treatment and structural measures installed in Andale, Spring Creek, and Mt. Hope Watersheds, total average annual direct damages will be reduced by about 80 percent. About 10,431 acres of agricultural land and the cities of Andale (population 511), Mt. Hope (population 659), and Wellington (population 8,928) are benefited.

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* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

Applications for assistance in planning and carrying out works of improvement have been received on four additional watersheds. Two of these (Goose and Clear Creeks) were terminated in the preliminary investigation phase. One other (Sand Creek) is in the work plan process of development. The fourth watershed (Ark Tribs) is awaiting priority for planning.

There is some activity toward organization in six other watersheds totaling about 850,000 acres. These are Upper and Lower Cow Creeks, Upper Little Arkansas River, Cowskin Creek, Park City, and Derby Watersheds.

Resource Conservation and Development Projects

The Food and Agriculture Act (P.L. 87-703) authorizes the organization of Resource Conservation and Development projects. The program authorizes technical, financial, and loan assistance to legal sponsors in approved areas where acceleration of existing resource conservation programs will increase economic opportunity for local people.

A Resource Conservation and Development project is a locally initiated and sponsored activity to expand the economic opportunities for the people of an area by developing and carrying out a plan of action for the orderly conservation, improvement, development, and wise use of their natural resources. The concept of a Resource Conservation and Development Project is that of local people of an area engaging in total development and use of all resources through self-government, conservation, and development at the local level. The Soil Conservation Service is responsible for the administration of U.S.D.A. activities and for contacts with other federal agencies outside the Department and with state and local agencies and organizations in a position to further such projects.

Most of the authorized Sunflower Resource Conservation and Development Project is included in this unit. The project area includes all of Kiowa, Comanche, Barber, Pratt, Kingman, Harper, and Sumner Counties (see pages 13-14 for current RC&D status and basin area involved).

Flood Control Projects

Four local protection projects have been constructed with this unit. All are under jurisdiction of the Tulsa District, Corps of Engineers. (Exhibit 34)

(1) The $5.8 million Hutchinson project, consisting of a canal and levee to divert flood flows of Cow Creek to the Arkansas River and thence past the city between levees, was completed in 1955.

(2) The $18.8 million Wichita and Valley Center project was completed in 1959. This project consists of floodways and diversions, together with appropriate control structures, designed to protect Wichita, Valley Center, and rural areas from floodwaters of the Little Arkansas River, the Arkansas River, Big Slough, and Cowskin and Chisholm Creeks.

(3) A $0.5 million channel improvement project for protection of Newton was completed in 1967. This project consists of 5 miles of improvement of Sand Creek channel through Newton and clearing and snagging both upstream and downstream of the new channel.

(4) The West Branch of Chisholm Creek near Wichita was straightened and the capacity was increased in order to protect about 2,300 acres of farmland and some urban property. This small flood control project, located upstream from the existing Wichita and Valley Center project, was completed in 1963 at a cost of $0.75 million.

One additional project of the Tulsa District, Corps of Engineers, has been authorized for construction. The Cow Creek plan of improvement calls for straightening, snagging, clearing, and deepening of the existing channel from Lyons downstream 33 miles to Hutchinson. This $1.8 million plan was authorized in 1962.

Cheney Reservoir is located on the North Fork Ninnescah River. This project, completed in 1964 by the Bureau of Reclamation, controls runoff from 901 square miles and has 80,860 acre feet allocated for flood storage; 151,780 acre feet for conservation storage; 14,310 acre feet for fish and wildlife storage; and 980 acre feet reserved for sediment.

<u>Irrigation</u>

Irrigation has not developed as extensively in the Lower Arkansas Unit as in some parts of the state, although

it did increase significantly during the 1950's drought. Between 1952 and July 1, 1959, the acreage covered in irrigation water rights and in water rights pending approval increased from 6,292 acres to about 109,000 acres. Generally only a part of the water approved for irrigation use is actually utilized. A current estimate puts the irrigated acreage at 100,000 acres compared to the state total of 1,700,000 acres. Groundwater is the source for 163,800 acre feet of water required annually. Surface water is the source for 16,200 acre feet. (Exhibits 19, 20, 21, and 22)

SPRINKLER IRRIGATED CORN ON FINE SANDY LOAM IN KIOWA COUNTY.

Drainage

Twenty-three drainage districts have been in operation at one time or another in this unit. Only 12 of these are known to be active at present. Pertinent information regarding the 12 active drainage districts is as follows:

Name	Area (acres)	Year Organized
Reno County #3	4,240	1950
Valley Township (Reno County)	3,600	1950
Yoder Township (Reno County)	4,600	1951
Grant Township (Reno County)	5,000	1951

Name	Area (acres)	Year Organized
Cow Creek # 3 (Reno County)	320	1950
Blaze Fork #1 (McPherson County)	4,500	1917
McPherson County #2	6,800	1918
McPherson County #3	6,800	1918
McPherson County #4	2,100	1948
Little Arkansas River (Harvey Co.)	9,600	1953
Big Slough (Sedgwick County)	10,520	1916
Big Arkansas (Sedgwick County)	5,400	1951
Cowskin (Sumner County)	14,000	1916
Harvey, McPherson, and Reno Co. Drainage District No. 2	3,600	1948
	81,080	

Water Supplies for Rural Domestic and Livestock Uses

Rural water districts have been given powers adequate to develop such supplies or to contract with others in order to satisfy the water need. Financing of water supply systems is usually accomplished by loans insured by the Farmers Home Administration. Ten rural water districts have been organized in this unit since 1963. Information regarding these ten districts is as follows:

Name	Year Organized	Number of Families Served	Status 6-1-71
Harper County No. 1	1965	20	Under Construction
" " No. 2	--	66	Organized
Reno County No. 1	1963	26	Operating
Sedgwick County No. 1	1967	110	Organized
Sumner County No. 1	1967	74	Operating
" " No. 2	1965	79	"
" " No. 3	--	23	"
" " No. 4	--	80	Organized
Comanche County No. 1	--	54	Operating
Barton County No. 1	--	11	Organized

Most of these rural water districts obtain water from nearby cities.

Municipal and Industrial Water Use

All of the municipalities in the unit except Wellington and Wichita are currently utilizing groundwater. (Exhibit 27) Water for Wellington is obtained primarily from a city-

owned lake supplemented by shallow wells and an overflow dam on the Chikaskia River. Water use for the Wichita system accounts for over one-half of the total municipal water used in the entire unit. Wichita has been getting one-fourth to one-third of their total water supply from Cheney Reservoir and have the capability of getting considerably more if necessary.

Although most of the industries in the unit obtain water from municipal supply systems, a substantial number have their own systems. Almost 99 percent of the industrial water rights are for groundwater sources.

Recreation

The general discussion of the Land and Water Conservation Fund Act beginning on page 56 also applies to this unit.

Existing recreational lakes in the unit include Cheney Reservoir; four state lakes in Kiowa, Barber, and Kingman Counties; Cheyenne Bottoms, a State Forestry, Fish and Game Commission wildlife refuge in Barton County; the Quivira National Waterfowl Refuge in Stafford, Reno, and Rice Counties; three county owned lakes - the Pratt County Lake, Lake Afton in Sedgwick County, and the lake formed by the Harvey County overflow dam on the Little Arkansas River; Lake Inman in McPherson County, the only natural lake in this area; city recreational lakes formed behind overflow dams at Newton, Halstead, Wichita, Wellington (on Slate Creek), and Caldwell; a city recreational lake at Anthony; the Wellington municipal reservoir on a tributary to the Chikaskia River and the municipal lake behind the overflow dam on the Chikaskia River; and the Rock Island overflow dam near Caldwell. There are also watershed structures and numerous farm ponds in the unit that may be used for private or limited public recreation.

Capacities, surface areas, and drainage areas of ten lakes for which information is available are as follows:

Name	Capacity Acre Feet	Surface Area Acres	Drainage Area Sq.Mi.
Kiowa County State Lake	168	21	2/
Barber County State Lake	880	77	3.8
Pratt County State Lake	450	95	-
Kingman County State Lake	700	185	3.8
Cheyenne Bottoms Lake	24,080	12,290	-
Lake Afton	2,980	233	10.5
Wellington Municipal Reservoir	3,070	350	18.0
Anthony City Lake	950	135	23.0
Caldwell Overflow Dam	60	16	-
Cheney Reservoir	151,780 1/	9,550	903.0

1/ No specific allocation to recreation made
2/ Lake is filled by pumping

BOATING ON A RESERVOIR IN SPRING CREEK WATERSHED, SEDGWICK COUNTY.

Fish and Wildlife

Forestry, Fish and Game Commission biologists conduct surveys and evaluate fish and wildlife within the unit annually. Fish stocking and rehabilitation programs are initiated when needed and when funds are available.

The Forestry, Fish and Game Commission restocked prong-horn antelope in Barber and Comanche Counties in 1965 and

1967. (Exhibit 10) There has been a moderate increase in these animals. The Commission has recently transplanted wild Rio Grande turkeys in the unit with apparent success.

Six areas have been designated as public hunting areas in the Lower Arkansas Unit. (Exhibit 8) Two of these are large waterfowl refuge areas. Quivira National Wildlife Refuge in the northeast corner of Stafford County is administered by the Bureau of Sport Fisheries and Wildlife and is open to the public. Cheyenne Bottoms Waterfowl Management Area in Barton County, a 12,000 acre area, is state-owned and managed. A 4,820 acre area in northwestern Pratt County is managed specifically for upland game birds. Three areas are associated with bodies of water. One is a game management area at Cheney Reservoir, leased from the Bureau of Reclamation, and the other two are areas adjoining state-owned Kingman County and Barber County State Lakes.

Cooperative State-Federal Forestry Programs

The Walnut-Verdigris Unit includes discussion of cooperative state-federal forestry programs beginning on page 212.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Land Use and Conservation Treatment

Land treatment measures have been installed on 38 percent of the cropland area. Residue management, stripcropping, and terracing are the major conservation needs for the dryland farming area. The most needed treatment on irrigated land is planned irrigation systems to efficiently convey and apply water without excessive erosion or water losses. Permanent cover should be established on approximately 60,327 acres. Nearly one-half of the rangeland has received adequate conservation treatment. The principal measures needed to complete treatment of the rangeland are proper grazing use, range seeding, and brush control.

It is reasonable to project that about 71 percent of the cropland treatment needs and about 82 percent of the rangeland treatment needs can be accomplished by the year 2000. Projections assume continuation of current incentive programs and are based upon established trends.

MORE THAN HALF OF THE RANGELAND IN THE LOWER ARKANSAS UNIT NEEDS CONSERVATION TREATMENT. THIS RANGELAND SCENE IS IN PRATT COUNTY.

A large part of the unit's woodlands are on sites capable of excellent timber growth--over two-thirds are rich bottom land and side drainage sites. However, only one acre out of three is adequately stocked at present.

Upstream Impoundment Sites

Floodwater retarding structure sites are available where needed for reduction of flood flows in most of the unit. It is usually desirable to locate sites as close as possible to primary damage areas for maximum damage reduction. This goal is attainable in most watersheds of the unit. Some areas along the mainstem Arkansas River and in the Rattlesnake Creek subbasin are too flat to offer any sites. (Exhibit 36)

A total of 1,032 physically possible floodwater retarding structure sites were examined in the unit during this study. Data was developed for 584 of these sites. Site characteristics range from poor to excellent. Contrary to criteria for storing water for long periods of time for supply purposes, shallow reservoirs of large surface area will generally produce flood control at lower cost than narrow, deep reservoirs. This may not be true for excessively long dams. About 75 percent of sites studied were classified as having better than average storage potential as floodwater retarding reservoirs. Sites typical of those having above average potential for flood control reservoirs are found in the headwaters of North Fork Ninnescah and Chikaskia Rivers. More expensive but still desirable from a physical standpoint are deep narrow sites of the Upper Medicine Lodge River area. Very few sites studied were judged to be inefficient for floodwater storage. An overriding factor that may produce excessively high costs is involvement with improvements such as roads, pipelines, farmsteads, railroads, and oil wells. As many as 20 percent of the sites studied may fall into this category.

Four of the watersheds studied did not have any sites available with over five square miles of drainage area. An equal number had sites available with over 100 square miles of drainage area. The maximum size site studied was 276 square miles.

Total drainage area controlled by the 584 sites studied in detail is 4,383 square miles or 38 percent of the unit area. Some sites are in series. No sites were included on the mainstem Arkansas River. No sites were studied that exceed maximum size limitations under Public Law 566. Most of the sites inventoried involve more pastureland than cropland.

Economic factors will limit development of floodwater retarding structure systems in most watersheds of the unit. Damage rates are generally low because of infrequent flooding or low value floodplain lands. Benefits are not large enough to offset costs of development. Where benefits are more plentiful but still marginal, any formulated structure system will contain structures with large drainage area size.

Channel Work

Streams in the unit generally have large enough channels so that channel improvement would not be a practical method of flood damage reduction. Channel improvement will probably be necessary as a measure added to land treatment and floodwater retarding structures in three watersheds. In these three, channels are too small to carry structure release and uncontrolled flows from more frequently occurring storms.

Agricultural Water Management

Storage - Surface water storage for irrigation use is not generally efficient in this unit except in sites where storage would be deep in relation to surface area. Shallow reservoirs with large surface areas expose too much area to high evaporation and seepage rates. Low yield in relation to loss and use requires large quantities of carry-over storage in order to provide needed water during long drought periods.

Exceptions to the aforementioned generalizations exist in this unit. Although deep, narrow reservoir sites are available in several watersheds of the unit (example Medicine Lodge River), yield will be inadequate to make use of available physical storage. On the other hand, generous yield from unusually high base flow may produce irrigation storage potential in sites otherwise unfeasible because of large surface area to depth ratios (example some parts of the Chikaskia River subbasin).

The general discussion beginning on page 61 also applies to the potential for rural domestic and livestock water supply development and groundwater recharge in this unit.

One hundred thirteen sites were recognized to have some degree of physical potential for multiple-purpose development. Only about 20 percent of these sites were classified as being above average in water storage characteristics. Most of the sites that have potential for multiple-purpose development are in the Medicine Lodge and Chikaskia River subbasins. (Exhibit 37)

Drainage - Several potential solutions exist for the removal of surface water in the sandy, undulating lands typified by northern Stafford County. The first logical step appears to be establishment of a basic channel system that outlets into a defined stream. The channel system would extend far enough into the problem areas to provide outlet for on-farm drainage systems. Such extensive channel construction may be detrimental by lowering of the groundwater table. Extensive study of the effect on groundwater levels should be part of channel system planning. Diversion into recharge basins in sandy waste areas along channel routes may be a possible solution if negative effects on groundwater levels are encountered. Irrigation development without a coordinated plan for excess surface water removal must be halted. Land leveling or reshaping for irrigation development should be discouraged until adequate systems are provided for tailwater reuse and storm runoff removal. Level terraces should be applied on sloping, sprinkler irrigated lands to keep surface runoff from collecting in pot holes. This practice should be encouraged instead of reducing natural surface storage by filling pot holes.

Surface water removal impaired by high stream banks can usually be corrected with cross floodplain ditches emptying into the stream through water control structures with flap gates. Enlargement of existing road ditches will usually involve the least land and construction costs.

<u>Non-Agricultural Water Management</u>

The general discussion beginning on page 62 also applies to potential development of water supplies for municipal-industrial, recreation, fish and wildlife, or water quality control in this unit.

Availability of Land and Water for Potential Development

The 113 reservoir sites recognized as having multiple-purpose development potential in this unit have a physical storage capability of 635,000 acre feet. However, yield will limit the storage potential to approximately 127,000 acre feet. This volume is above the sediment and flood-water storage reserves that would be necessary for single purpose development. Water quality in impoundments will be adequate for most uses.

Non-irrigated cropland would be involved in development of the full storage potential of most sites. The possibilities of encroachment on roads, farmsteads, or pipelines increase as storage is increased in most sites. Railroads or highways would be involved in a few cases. No towns would be affected by any of these sites. Other larger sites not investigated are likely to involve more serious encroachment on physical improvements.

LOWER ARKANSAS UNIT

OPPORTUNITIES FOR DEVELOPMENT WITH USDA PROGRAMS

Land Treatment Measures

The general discussion beginning on page 65 also applies to opportunities for development of land treatment in this unit.

The total cost of installing the needed land treatment measures listed in Exhibit 17 for the Lower Arkansas Unit is estimated at $40,000,000.

Upstream Watershed Projects

The general discussion of program provisions beginning on page 66 also applies to opportunities for P.L. 566 development in this unit.

Early Action Projects - Five upstream watersheds within the Lower Arkansas Unit were found to be feasible and needed within the next 10-15 years. These five are in addition to watershed projects that have already attained planning status or beyond.

Watershed Name	CNI No.	Drainage Area Acres
Blood Creek	1m-1	109,350
Upper Cow Creek	1m-2 (part)	256,442
Little Cow Creek	1m-3 (part)	226,093
Upper Little Arkansas River	1n-1	205,651
Shoo Fly Creek	1q2-6	88,531
Total		886,067 1/

1/ From CNI drainage areas

These five watersheds include an area of nearly 886,067 acres in Kansas or 11.9 percent of the Lower Arkansas Unit. Interest has been shown in organization of watershed districts

covering Upper and Little Cow Creek and Upper Little Arkansas River. No organized activity has taken place in Blood or Shoo Fly Creek Watersheds. (Exhibit 38)

It would be possible to economically control about 396 square miles or 29 percent of the area included in the five feasible watersheds. These figures are based on an estimate of the physical, economic, and social aspects of each watershed. Local interests may have valid reasons for variation from systems selected for this study. Variation from the systems for which data is summarized would produce different physical and economic values.

The 396 square miles of control can be accomplished by installation of 32 reservoirs. It is estimated that 27 of these sites will be single purpose floodwater retarding structures and 5 will be multiple-purpose floodwater retarding and recreation structures. Total storage capacity of the 32 structures will include: sediment, 17,261 acre feet; detention, 62,396 acre feet; and recreation, 4,065 acre feet. Surface area totals are: sediment pools of single purpose floodwater retarding structures, 1,839 acres; permanent pools of multiple-purpose floodwater retarding and recreation structures, 1,076 acres; detention pools (all structures), 8,059 acres. (Exhibit 39)

A total of 16 miles of channel improvement is considered necessary in two watersheds in order to increase the level of protection. The improvement would consist primarily of clearing, enlargement, and alignment changes on Blood Creek and Little Cow Creek. Other alternatives exist for channel improvement location and design. Specific information must await more detailed study.

Drainage may be accomplished through watershed projects when such projects prove physically and economically feasible. This type of project is most desirable when prevention of future damages by surface water removal is the major goal. Less desirable projects are those deriving major benefit from land enhancement. The applicability of P.L. 566 to specific drainage problems of this unit will need further study.

Long Range Projects - There is one additional watershed that merits future consideration for project development. At present it is not economically feasible because of high interest rates, high costs, and evaluation procedures. This project should be re-evaluated if economic factors improve. This project includes 35 square miles, 63 percent of which could be controlled by four structures. Total storage capacity would probably include: sediment, 1,655 acre feet; detention, 6,987 acre feet; and recreation, 300 acre feet. Surface area totals are: sediment pools of floodwater retarding structures, 100 acres; permanent pools of multiple-purpose structures including recreation storage, 298 acres; detention pools (all structures), 1,301 acres.

Cooperative State-Federal Forestry Programs

Forest land treatment measures are needed to supply quality timber for present and future generations. The land treatment measures will be maintained by landowners and operators. The following table lists estimated land treatment measures proposed on state and private forest lands, Lower Arkansas Unit, to 1980 (estimated cost - $3,433,400):

Item	Unit	Amount
Timber surveys	Acres	58,000
Forest management (technical assistance) timber thinning, pruning, and releasing	Acres	40,000
Growing and distribution of seedling trees for reforestation and wind barriers	Trees	20,000,000
Tree planting and seeding	Acres	34,000
Insect and disease control program	Acres	15,000
RC&D programs	Counties	7
Fire control programs	Acres	15,000
Cooperative watershed protection and flood prevention	Acres	92,000
Investigative studies concerning marketing and utilization of forest products (pulp-wood market survey)	Acres	58,000

Resource Conservation and Development Projects

Most of the authorized Sunflower Resource Conservation and Development Project is included in this unit. The broad objectives of the project are the orderly development of natural resources, the establishment of a more balanced economic base, and the improvement of the total environment. Rural and urban renaissance is possible through the RC&D program. The project can provide the catalyst to forge the wide cross-section of people together for the overall improvement of the area.

One of the basic problems of the project area is the need for complete development and utilization of the land

and water resources. Developing other resources, including human resources, depends on proper use of land and water.

Opportunities lie in broadening the following:

1. Land and water conservation program, including irrigation.

2. Complementary and diversified small industry.

3. Vocational training for agricultural and processing industries.

4. Rural facilities (trade, health, cultural, and transportation).

5. Recreation development

6. Community renewal program (Section 701 of the Housing Act of 1954, as amended).

7. Agriculture and agri-industries.

The Sunflower RC&D Project sponsors are the seven (7) county Soil Conservation Districts and the Boards of County Commissioners. A project steering committee composed of 21 members provides leadership. One representative from each project sponsor and one member at large from each county serves on the steering committee.

The project sponsors depend upon participation by and assistance from local, state, and federal agencies in carrying out their plan. Assistance includes acceleration of "going programs" as well as new programs and broader authorities that may be created.

Local people have prepared and submitted to the project sponsors a total of 249 proposed project measures.

Functional Committee	No. of Proposals	Total Estimated Costs
Agriculture	48	$ 10,427,500
Beautification	15	375,150
Cultural and Social	28	1,184,500
Education	16	1,938,500

Functional Committee	No. of Proposals	Total Estimated Costs
Facilities and Services	33	$102,609,050
Finance	10	1,081,000
Human Resources	2	15,000
Industrial Development	12	901,000
Local Government	9	17,300
Specialty Resources	39	2,049,100
Tax Structure	5	51,000
Water	32	156,168,000

The project plan is "open-end". As operations proceed additional proposals for project measures will be submitted by local people. When evaluated, some of the project measures may not be feasible. No attempt has been made to study or evaluate the feasibility of each proposal.

RECREATION DEVELOPMENT, SIMILAR TO THIS BARBER COUNTY LAKE, IS AN OBJECTIVE OF THE SUNFLOWER RESOURCE CONSERVATION AND DEVELOPMENT PROJECT.

Rural Water Districts

Along the southern tier of counties in this unit there are problems with the quantity and quality of groundwater supplies. Future rural water district development can be expected in this area. (Exhibits 22 and 27)

Although there is potential for use of watershed structures as a source of supply for rural water districts, it appears that the trend is to utilize an existing municipal supply. There is a question as to whether some municipal systems being expanded to include rural water districts can maintain adequate supplies during severe drought periods. There are towns now supplying rural water districts which have had shortages in the recent past.

Rural Electrification Administration

The discussion on page 69 also applies to the Rural Electrification Administration Program in this unit.

IMPACT OF USDA PROGRAMS

Land Treatment Measures

The general discussion beginning on page 70 also applies to the impact of land treatment in this unit.

Land treatment benefits in this unit, from flood reduction in planned watershed projects and those authorized for planning or recommended in the early action projects, will average $47,700 annually.

Upstream Watershed Projects

The discussion beginning on page 70 also applies to the general impact of watershed development in this unit.

Existing Projects - Floodwater and sediment damages will be reduced to a varying degree for 15,016 acres of floodplain upon completion of the five existing projects. (Exhibit 18) Existing projects include those having attained the status of planning authorization or beyond. Average annual damages will be reduced some 64 percent by these projects. Total expected benefits are as follows:

Flood Damage Reduction	$100,300
Recreation (as a purpose)	34,900
Land Enhancement	29,200
Off-Project	2,600
Local Secondary	24,800
Total	$191,800

Average annual cost of structural measures included in existing projects totals $114,100. Comparing total benefits to total costs produces an overall ratio of 1.7:1 for these five projects. (Exhibit 40)

Early Action Projects - Installation of works of improvement under P.L. 566 in the five feasible early action projects will directly benefit 53,548 acres of floodplain lands within the watershed areas. (Exhibit 18) In addition, the works of improvement will provide benefits to downstream floodplain, outside the watershed boundaries.

It is estimated that average annual flood damages can be reduced 49 percent through installation of land treatment and structural measures in the five watersheds. This reduction can be accomplished with a physically and economically feasible system in each watershed. Economic effects of one such possible system for each watershed are summarized in this report. (Exhibit 41)

Average annual benefits for the five watersheds are: flood damage reduction, $298,200, of which $39,000 is to land treatment and $259,200 to structural measures; recreation (incidental and as a purpose), $209,800; land enhancement, $38,000; off project, $116,800; and local secondary, $56,100; for a total of $679,900.

Average annual cost of structural measures to be installed in early action projects is $573,500. The ratio of total benefits to total costs for these five projects is 1.2:1.

Recreation benefits evaluated were for structures with cost estimates including storage for recreation use. Five of the reservoirs fall into this category. Combined surface area of recreation pools is estimated to be 1,076 acres.

Long Range Projects - One additional watershed project including 56 square miles may someday become economically feasible. This project would benefit 1,954 acres of flood-plain land. The average annual benefit and cost figures for this project are:

Benefits	$67,000
Costs	$81,800
Benefit-Cost Ratio	0.82:1

Forest and Grassland Management Programs

Tree planting in the past has been primarily for protection from wind, conserving moisture, and preventing erosion.

The earlier windbreaks and farmstead shelterbelt plantings are now over 30 years old. They have demonstrated their usefulness for many years and in many instances owners of these windbreaks have gathered good crops on the lee side

of them despite prevailing dry conditions. Roadside tree plantations and attractive rest areas contribute to greater highway safety. Tree planting for noise abatement offers a great deal of promise along heavily traveled highways and noisy airports.

THIS RICE COUNTY SHELTERBELT HAS DEMONSTRATED ITS MANY BENEFITS SINCE IT WAS PLANTED IN 1940.

Other general discussion beginning on page 228 applies to the impact of forest management in this unit.

In 1964, timber-based industries employed 760 people, but this is expected to rise to 1,305 by the year 2020. (Exhibit 42) The estimates are based upon the anticipated timber cut and upon improvements in the output per man day.

Resource Conservation and Development Projects

Total cost of installing all Sunflower RC&D project measures is estimated at $276,816,550. Measures are expected to be installed within 10 years. Economic benefits are expected to come from project expenses for installation and annual operation and maintenance costs and returns on

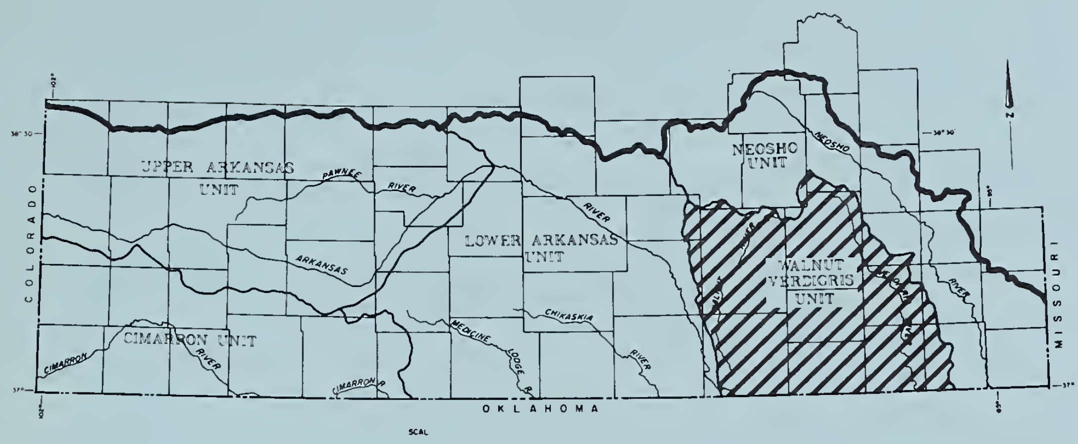
private investments. Once installed, the measures should increase annual income of the area by at least $44,300,000.

Aside from monetary benefits, there will be many intangible benefits difficult to identify or measure. Proposed improvements in educational systems, water and sanitation facilities, housing, transportation, community parks, beautification, etc. should create a more favorable environment for economic growth. Installing these measures should result in an environmental mixture needed to attract new business and industry, besides providing local residents a better place to live. Proposed measures involving private investments and business expansion should contribute much in terms of increased employment and income.

Rural Water Districts

It is estimated that there will be considerable impact in this unit from the development of rural water districts. A recent study of impact in one particular district (Economic Impact of a Rural Water District, Smythe, Patrick; Dept. of Economics; Cooperative Extension Service; Kansas State University; August, 1969) indicates an increase in value added to land and home improvements, an increase in live-stock production, and a savings from hauling water. The value added or saved in the district studied was almost ten times the original investment of $125,000 over a five-year period. If the value added or saved over a five-year period is five to ten times the cost, then based on expected development, rural water districts will have considerable economic impact.

WALNUT-VERDIGRIS UNIT



Land Use -	Cropland	-	1,231,500 acres
	Rangeland	-	2,555,900 acres
	Forest	-	216,900 acres
	Other	-	373,000 acres
Total Area		-	4,377,300 acres

Total Capability Class I, II, III, and IV Land - 2,769,700 acres (63%)

Irrigated Acreage - 6,500 acres (1971)

Average Annual Precipitation - 30 to 40 inches

Land treatment is adequate on 467,600 acres of cropland (38%) and 1,167,700 acres of rangeland (46%)

The total cost of applying needed crop and pasture land treatment is estimated to be $21,000,000

The total cost of applying needed forest land treatment is estimated to be $8,195,500

Floodwater and sediment damages on tributary streams average $4,858,500 annually--some 262,800 acres are subject to inundation

P.L. 566 Watershed Projects Completed or Authorized for Construction - Thirteen

Active P.L. 566 Watershed Projects Authorized for Planning - Six

Two feasible Early Action watershed projects are needed within the next 10-15 years

Seventeen additional watersheds merit consideration for Long Range project development

WALNUT-VERDIGRIS UNIT

NATURAL RESOURCES

Location and Size

The Walnut-Verdigris Unit includes an area of 6,839 square miles or 4,377,267 acres of southeast Kansas. This area is about 16 percent of the Arkansas Basin in Kansas. The drainage system consists of the main stream and tributaries of the Walnut River, Grouse Creek, and the Verdigris River. All three streams are tributaries of the Arkansas River. The drainage areas are:

Name	Area in Square Miles
Walnut River	1,992
Verdigris River including Fall River and Caney River	4,373
Grouse Creek and other small direct Arkansas tributaries	474
Total	6,839

Counties entirely within the unit are Elk, Montgomery, and Chautauqua. Counties partly included are Harvey, Marion, Butler, Sedgwick, Sumner, Cowley, Chase, Lyon, Greenwood, Woodson, Wilson, Neosho, and Labette. (Exhibit 1)

Climate

Climatic classification ranges from subhumid continental in the western two-thirds of the unit to humid continental in the eastern third. Masses of warm, moist air from the Gulf of Mexico alternate with cooler, moist air from the West Coast or with colder, dry air from the Arctic Circle. Changes in air masses often are quite rapid and are accompanied by changes in temperature, cloudiness, wind, and precipitation.

Average annual precipitation ranges from 30.5 inches in southeast Harvey County to 39.5 inches in western Labette County. (Exhibit 2) Precipitation, although usually adequate, varies considerably from month to month and from year to year. The largest total annual precipitation recorded at Howard, near the center of the unit, is 56.07 inches in 1961 and the

smallest is 18.47 inches in 1956. This sort of variation is typical of all stations in the unit.

The driest season is winter, while late spring and early summer are usually the wettest periods. Average monthly precipitation at Howard exceeds 2 inches in all months except December, January, and February. Heaviest precipitation is in June with rainfall averaging over 5 inches. There is less rainfall in July and August but precipitation increases in September. In periods when rainfall is heaviest, much of it comes in thunderstorms.

An average of three-fourths of the annual rainfall occurs during the 7-month period, April through October. This distribution, which coincides closely with the average freeze-free period, favors growth of crops and grasses.

Snowfall is light averaging 12 to 14 inches per year. Snow that accumulates on the ground usually melts within a few days. Blizzards are infrequent and generally of short duration.

Droughts of several years duration seldom occur in the area. Precipitation in a particular year may be unusually low but rarely does a dry weather period extend for more than a year. The two most recent extended drought periods were 1931-1940 and 1952-1957.

Average annual lake evaporation ranges from 50 to 56 inches in this unit. Two years out of 100, annual lake evaporation will exceed average evaporation by about 30 percent.

Temperature patterns recorded at the weather station near Fredonia are typical for the unit. January and July temperatures average about 34 and 81 degrees respectively. Extremes in temperature range from 121 degrees, recorded July 18, 1936, to -26 degrees, recorded February 13, 1905. The average length of frost-free period ranges from 190 days in Butler County to 200 days in Chautauqua County. Freezing temperatures at Fredonia were recorded as late as May 9 and as early as September 26.

Topography

The Walnut-Verdigris Basin is in the Osage Plains of the Central Lowlands physiographic province. The Flint Hills upland division covers the western part drained by the Walnut River. The Chautauqua Hills division is a wedge-shaped area thirty miles wide in eastern Chautauqua and western Montgomery County tapering to a point in southwest Woodson County.

TYPICAL HILL AND VALLEY LANDSCAPE IN CHAUTAUQUA COUNTY.

The major topographic features are the Walnut River valley, the southeast trending Verdigris valley, the broad rolling Flint Hills, and hilly step-like cuesta topography with low escarpments rising gently from east to west. The Chautauqua Hills are rugged with sandstone ledges exposed in the bluffs along narrow valleys bordered with dense stretches of blackjack and post oak timberlands.

FLINT HILLS VISTA, BUTLER COUNTY.

The tributary streams are deeply entrenched with floodplains less than one-half mile wide. The lower Walnut and Verdigris valleys will average one to two miles wide. The relief of the unit ranges from 660 feet above mean sea level to over 1,660 feet.

The soil capabilities of the unit result from the topography and underlying geology. These features account for the grazing lands of the Flint Hills, the cross-timbered Savannahs of the Chautauqua Hills, and the cropland areas of The Verdigris subbasin.

Geology and Soils

The Walnut-Verdigris Unit is underlain by rocks ranging from Middle Pennsylvanian Age through Upper Pennsylvanian and into Lower Permain Age. The rocks, which crop out over the basin, are limestones, cherty limestones, sandy shales, silty to clayey shales, and sandstones.

To the southeast, in western Labette County, the oldest or Middle Pennsylvanian rocks occur. These rocks include the Altamont limestone, Lenapah limestone, and the Nowata shale.

The Upper Pennsylvanian rocks outcropping in a north-northeast direction with several prominent east-facing escarpments cover most of the Verdigris subbasin and extend from Montgomery and Wilson Counties on the east to the west edge of Chautauqua, Elk, Greenwood, and Lyon Counties. The rocks are principally thick limestone strata interbedded with shale. Some massive sandstone and sandy shale beds occur near the middle of the area giving rise to the development of the Chautauqua Hills physiographic division. The total thickness is about 1,800 feet.

The Walnut River and tributaries are underlain by rock of Lower Permian Age. The gentle dip of the outcropping strata is west-northwest. Thick, resistant cream colored limestones, many of which are distinguished by an abundance of chert, form persistant, east-facing escarpments in the Flint Hills. Limestones and calcareous shales in the Flint Hills are characterized by abundant marine fossils.

Alluviums of Wisconsin and Recent Ages occupy the valleys of major streams and tributaries. Most of the deposits are silt and clay with some sand and gravel. The average thickness is 15-20 feet.

Soils on upland have formed predominantly in materials weathered from shale, limestone, and sandstone. (Exhibit 3) On the nearly level to sloping upland are moderately deep to deep, clayey soils. They are moderately to well drained. There are claypan soils in some of the nearly level and gently sloping areas. On the steep slopes are moderately deep to shallow, loamy soils. Rock outcrops are common on the steep slopes. The soils on the bottomland are loamy to clayey. They are deep soils and range from poorly to well drained.

Minerals

Oil and gas is of great economic importance. Millions of dollars worth of oil have been produced in the last 70 years. Oil fields are widespread over the unit. The largest and most productive is near El Dorado. The gas field near Dexter is noted for helium. (Exhibit 4)

Other minerals of less economic importance include limestone, sandstone, clay, shale, sand and gravel, and coal. Raw materials useful for construction projects include lime-

stone and alluvial deposits of gravel. Sand, gravel, and crushed limestone provide aggregate for concrete. Road surfacing material is available in large quantities from alluvial deposits and from crushed limestone when mixed with a silt and/or clay binder. Structural building stone is quarried from the Cresswell and Ft. Riley limestone formations. The most extensive quarries are near Silverdale. Limestones with high calcium carbonate content are crushed for agricultural use.

Thin coal beds, though not economical to mine, occur in widely scattered areas.

Land Use and Management

The Walnut-Verdigris Unit is divided into three major land resource areas in two separate land resource regions. Area 75, the Central Loess Plains, and area 76, the Bluestem Hills, are both in the Central Great Plains Winter Wheat and Range Region. Area 112, the Cherokee Prairies, is in the Central Feed Grains and Livestock Region. (Exhibit 5)

Land use for each land resource area in the Walnut-Verdigris Unit is as follows:

Land Resource Area	Cropland		Rangeland		Forest		Other		Total Acres
	Acres	%	Acres	%	Acres	%	Acres	%	
075	334,507	56	139,012	24	31,017	5	88,757	15	593,293
076	516,421	18	1,989,539	70	128,838	5	191,034	7	2,825,832
112	380,564	40	427,310	45	57,045	6	93,223	9	958,142
Total	1,231,492	28	2,555,861	58	216,900	5	373,014	9	4,377,267

Land use for the unit by land capability class is shown in the following table:

Land Capability Class	Acres by Land Use				Total
	Cropland	Rangeland	Forest	Other	
I	179,651	16,640	55,592	14,068	265,951
II	431,030	229,107	47,815	65,605	773,557
III	486,375	758,933	7,235	151,418	1,403,961
IV	83,795	200,528	3,022	38,846	326,191
V	0	0	0	0	0
VI	43,900	1,139,380	75,552	62,628	1,321,460
VII	6,361	211,273	27,684	22,229	267,547
VIII	380	0	0	18,220	18,600
Total	1,231,492	2,555,861	216,900	373,014	4,377,267

Approximately 13 percent of the unit lies in land resource area 75. Nearly all of this area is in farms and ranches. Fifty-six percent of the area is cropland. Winter wheat is the main cash crop. Grain sorghum and alfalfa are other crops utilizing large acreages.

Rangeland occupies 24 percent of land resource area 75. This is the mixed bluestem and short grass region of Kansas. Tall and midgrasses such as big and little bluestem, side oats grama, and prairie dropseed, occupy the slopes and stream bottoms while the short grasses, buffalograss, and blue grama grow on the thinner and poorer upland soils.

Cities and towns, roads, highways, railroads, water areas, and other non-agricultural land uses account for fifteen percent of land resource area 75. Forest land occupies 5 percent.

Land capability classes within land resource area 75 range from I through VIII, except for class V. Eight-nine percent of the area is classified as I, II, III, or IV land

of which 63 percent is utilized for crop production. Of classes VI through VIII, 96 percent is used as rangeland, woodlands, and other while only 4 percent is cropped.

The largest portion of the unit, 65 percent, lies in land resource area 76, the Bluestem Hills. Land use consists of 18 percent cropland, 70 percent rangeland, 5 percent forest land, and 7 percent other. Wheat, grain sorghum, soybeans, alfalfa, and other hay are the major crops.

The rangeland of resource area 76 occupies the area commonly called the Kansas Flint Hills. Vegetation in this area is composed primarily of big and little bluestem.

Cities and towns, roads, railroads, water areas, etc. make up the seven percent of land cataloged as other in land resource area 76.

Land capability classes, I through VIII excluding class V, can be found in the Bluestem Hills area of the unit. Forty percent of the area is classified as land capability class VI and 90 percent of this area is rangeland.

The southeast area of the unit is within land resource area 112, the Cherokee Prairies. Approximately 22 percent of the unit lies within this resource area. Rangeland occupies 45 percent of the area. Native grasses found in land resource areas 75 and 76 are the major species found in this area. Cropland represents about 40 percent of the total area. Wheat, grain sorghum, corn, soybeans, and alfalfa are grown on the major portion of the cropland area. Six percent of the area is woodland.

The remaining land in resource area 112 is utilized for purposes other than for direct agricultural use.

Seventy-six percent of the land in land resource area 112 is classified in land capability classes I through IV. One-half of this is cropland. Only 6 percent of classes VI through VIII are utilized as cropland.

Water Resources

Surface Water - Information about surface runoff and streamflow characteristics in the unit is currently obtained

from 17 continuous record stream-gaging stations: five on the Verdigris River mainstem, nine on tributaries of the Verdigris, one on the Walnut River mainstem, and two on tributaries of the Walnut. Eight of the gages have been established since 1953. Most of the tributary gages were installed during the period 1960-1965. Records for the Verdigris at Independence and the Walnut at Winfield date back to 1921. Thirteen partial record stations were recently installed to supplement the continuous record system.

Average annual runoff is more varied across the unit than is precipitation. (Exhibit 6) In the northwest corner of the unit average annual runoff (3.0 inches) is only about 10 percent of annual precipitation. The southeast corner has annual runoff averaging 10.0 inches which is about 25 percent of normal precipitation.

Values of mean yield are useful as a measure of total supply potential. They are not a measure of firm or even practical possible supply because steady flow does not occur under natural conditions. Knowledge of variability of flow is therefore important in water resource planning. The greatest range in annual runoff reflected in the recorded history of tributary streams is for Otter Creek at Climax where runoff in 1951 was about 450 times the minimum of 1953. Daily discharges fluctuate considerably more than annual runoff. All of the streams have experienced complete flow stoppage at one time or another. The maximum daily discharge in the unit is 106,000 c.f.s. recorded in 1943 on the Verdigris River at Independence. Extreme high daily discharges recorded for the longer term tributary gages include:

Station	Drainage Area (sq.mi.)	Maximum Daily Discharge (c.f.s)	Year
Fall River			
near Eureka	336	31,300	1951
near Fall River	591	32,200	1945
at Fredonia	827	39,300	1945
Otter Creek			
at Climax	129	12,000	1961
Elk River			
near Elk City	575	56,200	1961
Caney River			
near Elgin	445	37,000	1961

This unit includes some of the most frequent flooding streams in the state. Floods have occurred in practically all months of the year but most frequently in May, June, and July. Hydrologic studies reveal that the 100 year frequency flood event probably has not occurred during the period of stream gaging on several of the tributary streams. Maximum recorded flood peaks and data compared to the probable 100 year flood are shown in Exhibit 7.

As early as 1906-1907, quality tests were made on the Walnut River at Winfield by the U.S. Geological Survey. A regular or continuous sampling program was not initiated until 1956. Records of sporadic sampling at various locations are available for the interim. Currently the State Board of Health is collecting chemical data at six of the permanent gaging stations. Chemical quality data is also collected at three other sites. Sediment data is collected at five locations.

The water is more highly mineralized than desirable in the western portion of the Walnut subbasin. (Exhibit 6) Limited data reflecting conditions before man's influence indicate satisfactory natural chloride concentrations and higher than desirable total solids in the mainstem of the Walnut River and above desirable sulfate concentrations in the Whitewater River. Natural gypsum deposits along several tributaries in the western portion of the Walnut subbasin often result in excessive sulfate concentrations in the Whitewater and lower Walnut Rivers. Current records also indicate excessive chlorides, primarily in the north-central part of the Walnut subbasin. Most of the chloride pollution stems from poor oil field brine disposal practices of past

years. These practices have been improved since the late 1950's. Present chloride pollution results from leaching of brine from old disposal areas and from contaminated groundwater aquifers. The chloride content of affected streams has decreased in recent years but the leaching process can be expected to continue for many years.

The limited data available on composition of sediment in this unit indicate that at least 90 percent of the suspended sediment in most streams is silt or clay. Studies show the annual sediment production rate on major streams of the unit are probably in the range of 550 to 1,300 tons per square mile. Actual sediment yields are believed to vary considerably within the unit.

Groundwater - The basin's major river valleys produce sufficient groundwater for domestic and livestock needs. (Exhibit 22) The wells are shallow and of fair quality. Groundwater is not available in large enough quantities for municipal, industrial, and irrigation uses.

On the upland in parts of Cowley and Butler Counties, the east side of Elk and Chautauqua Counties, and the northwest corner of Wilson County, well water may be available for household and livestock needs. The wells may be deeper than valley wells and with a variable range in mineral content. The water is found in channeled limestone and sandstone formations yielding one to forty gallons per minute.

The yield is uncertain in other parts of the basin.

Fish and Wildlife Resources

Fishing waters in the Walnut-Verdigris Unit are plentiful. (Exhibits 8 and 9) The Walnut River, Whitewater River, Grouse Creek, Caney Creek, Caney River, Fall River, Elk River, and Verdigris River are the major fishing streams of the unit.

Lakes of more than 1,000 acres of surface area in the unit have a total combined surface area of 10,900 acres. Fall River, Toronto, and Elk City reservoirs account for 8,950 acres of the total area.

Floodwater retarding structures built under the P.L. 566 watershed program have a combined surface area in sediment pools of about 4,300 acres. In 1967 there were approximately 13,530 farm ponds in the Walnut-Verdigris Unit. This is an average of 1 pond for every 300 acres.

BASS ARE PLENTIFUL IN THIS ELK COUNTY FARM POND.

Wildlife of the Walnut-Verdigris Unit is influenced by the subhumid to humid climate. Whitetail deer and fox squirrel utilize the wooded area along streams. (Exhibit 10) Although no eastern turkey are presently found in the unit, biologists believe that habitat in Elk and Chautauqua Counties could support 200 to 300 eastern turkeys. The Flint Hills region of this unit contains potential habitat for antelope. None are present now, but transplants are being considered.

Whitetail deer, bobwhite quail, dove, greater prairie chicken, cottontail and jackrabbits, fox squirrel, and waterfowl are game animals found in the unit. Whitetail is the predominant species of deer and is the only big game animal harvested in the unit. A limited population of Rio Grande turkeys are present and may provide some trophy hunting in the future.

The areas of open pasture mixed with some farm crops provide habitat for the greater prairie chicken. The existence of this species is an important asset in the Walnut-Verdigris Unit. The unit's population is estimated at 50,000 birds (spring population). Kansas is one of the few remaining states containing sufficient number of prairie chicken to warrant hunting seasons. The greater prairie chicken is classified as a rare wildlife species in the United States.

Migrant mourning doves add to the harvestable resident or nesting populations associated with forest lands of the unit. Relatively dense populations of quail and cottontail rabbits utilize the habitat provided by brushy field borders of small farms.

GOOD WILDLIFE HABITAT IN LABETTE COUNTY

The Walnut-Verdigris Unit is located within the Central Flyway and numerous species of waterfowl pass through the area during spring and fall migration. The major areas hosting waterfowl populations in this unit include Fall River and Elk City Reservoirs. (Exhibit 8)

Migrating waterfowl provide many man-days of hunter recreation. In addition to the man-days of hunting provided

during the fall waterfowl season, a great amount of recreation is provided to the general public in the form of bird watching. This occurs primarily on waterfowl management areas during the spring migration period. It is difficult to place an aesthetic or appreciation value on these large waterfowl concentrations. Perhaps the value of viewing these large concentrations of waterfowl can only be realized should this resource be lost to future generations.

The more predominant furbearers of this area include mink, muskrat, beaver, raccoon, opossum, skunk, and coyote. The red fox is also present within the unit.

Many additional species of birds and mammals are present within the unit.

Forest Resources

The forests of the Walnut-Verdigris Unit occupy about 217,000 acres, or 5 percent of the area. Approximately 174,000 acres are classified as commercial forest land. The remaining 43,000 acres are considered non-commercial forest lands. (Exhibits 11 and 12)

Much of the original timber has been cleared for agriculture. The remaining scattered woodlands have been partially depleted by poor cutting practices, fire, and heavy grazing. Present forests contain many undesirable trees and are badly in need of forest management treatments. At least 70 percent of the forested area needs some type of silvicultural treatment to increase the desirable trees and reduce competing vegetation. The forests are important to the culture and economy of the unit.

All of the forest land in the unit is privately owned. (Exhibit 11) The condition of the forest lands, the type of forest management applied, and future timber growth all depend on the decisions of the private landowners. Most owners of forest lands are unfamiliar with forestry opportunities and procedures. Many of these owners lack the capital necessary for silvicultural stand improvements needed, or are not interested in timber growing. Ownership is an important factor in determining forest inventory trends and future timber supply.

Sawtimber volumes on commercial forest land total about 225 million board feet, while growing stock trees total approximately 95 million cubic feet. (Exhibit 14) The average commercial sawtimber volume per acre is 2,435 board feet. Over 50 percent of the total volume is found in sawtimber-size trees. Approximately 55 percent of the total sawtimber volume is found in the oak-elm-sycamore species group. The remaining 45 percent is hackberry, ash, cottonwood, black walnut, pecan, willow, hickory, maple, and other miscellaneous hardwoods. (Exhibit 13)

ALONG THE ELK RIVER IN ELK COUNTY IS MUCH HIGH-QUALITY COTTONWOOD SAWTIMBER.

Photo by: Kansas State Extension Forester

Sawtimber cut in the unit is very low, amounting to only 3 million board feet in 1964. This cut volume amounts to only 1.3 percent of the sawtimber inventory. Trend growth-cut comparisons indicate that both growing stock and sawtimber removal can be increased somewhat above present levels. If timber products output increases as anticipated, the cut should soon rise. It is expected to climb to an estimated 11 million board feet by 2020. (Exhibit 43)

Thirteen wood-using plants were operating in the unit in 1964. (Exhibit 46) In addition to 9 sawmills, there were 3 miscellaneous plants and 1 cooperage mill. Only one of the sawmills cut over 1 million board feet of lumber and other products in 1964. Sawlogs, veneer logs, and cooperage logs as a group constituted nearly 86 percent of the sawtimber roundwood output. (Exhibit 15) These logs are considered the most important forest product. They have a high value and account for the largest drain on the growing stock.

In 1965, some 240 people were employed in the timber-based industries in the unit. These people were employed in timber harvesting, at sawmills, cooperage mills, charcoal plants, and at miscellaneous plants. (Exhibits 42 and 46) Timber harvesting accounts for 17 percent of the employees. Persons employed do not include employment in forest management, protection, and secondary manufacturing of timber products.

Much of the timber-based activity is concentrated in rural areas where other industrial enterprises do not exist. In many areas sawmills, cooperage mills, and other wood-using plants are the main sources of local industrial employment.

Quality of the Natural Environment

Man has probably changed the natural environment less in this unit than in any other part of the basin. The native vegetation of the Flint Hills is essentially intact. These rugged, green hills with their white limestone rimrocks are truly beautiful from late spring through fall. Here man has found that his needs can be best served with little change.

LIMESTONE OUTCROPPING IS COMMON ON THE STEEP SLOPES OF GREENWOOD COUNTY.

Those changes brought about by agriculture in the Flint Hills are both good and bad. Stockwater ponds dot the landscape with sparkling blue. On the other hand, the practice of burning old vegetation in early spring not only pollutes the air with billowy clouds of smoke but also exposes the earth to serious erosion by spring rains. The grass bounces back rapidly after the spring burning and soon the hills are again a lush green background for the grazing cattle.

Farther south the mesa-like uplands are used for crop production and grassland. The steep hillsides are generally forested. The broad valley floors are rich crop producers. Bands of timber grow along the stream channels. Such diverse land use not only supports a strong livestock-feed grain program but also provides a very attractive landscape. Add to this setting man-made reservoirs of various sizes with clear blue waters and the picture is one of beauty.

Forests of the Chautauqua Hills portion of the unit provide one of nature's real displays of beauty. Fall colors of the oak, hickory, and maple trees are spectacular. A profusion of red, yellow, gold, green and purple color is there for man's enjoyment each fall.

Oil underlies much of the unit. In exploiting this resource, man laid waste to some of the lands. Much progress has been made in correcting this and the industry now fits into the overall picture with a minimum detraction of the environmental quality. Erosional scars still mar the landscape in some of these areas.

Winters are not particularly severe in this unit but occasionally a blizzard will leave the landscape totally white for several weeks. The summers usually have long periods of hot humid days interspersed with spectacular thunderstorms. At times, heavy rains produce flooding and a resultant detraction from the valley greenery. These extremes usually come without warning. One condition that natives do count on is the many clear sun-filled and breezy days.

The serenity of rural life is evident. Even in the larger cities like El Dorado, Winfield, Arkansas City and Independence, a small town atmosphere is felt. Parks are well kept, flower gardens and trees abound and the people's appreciation of beauty is evident.

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

Watershed Protection and Management

Erosion and Sediment Damage - Soil erosion is one of the most damaging problems to the unit's environment. Widespread sheet erosion on cropland ranges from slight to severe depending on farming practices, conservation treatment, and land capabilities.

Sheet erosion causes the greatest soil loss. Some damage to land is caused by rill and gully erosion. Most of the severe erosion occurs on steeply sloping cropland with shallow to moderately deep soil without conservation treatment. Here, removal of topsoil exposes less productive subsoil.

Soil loss through erosion has permanently reduced the productive capacity of large upland areas. This is related more closely to land best suited for grass that has been put to cultivation and exposed to accelerated erosion.

Abnormal soil losses occur when pastureland has consistently been overgrazed. Pastures in poor to fair condition are exposed to accelerated sheet and gully erosion. Erosion damages result in loss of production on voided and severely depreciated areas and reduced production on moderately eroded land.

Land stabilization problems in the unit are generally of an extent that may be solved through individual action with on-farm land treatment measures. The project approach to grade stabilization is not needed.

Channel erosion occurs on many tributary streams in the Flint Hills where grades are steep. Erosion in the channels is controlled by erosion resistant bedrock on the stream bottom. Streambank erosion while severe in small, local areas on the larger rivers is not of economic importance. Each problem area may be treated separately.

Floodplain scour is quite severe on the floodplains of the tributaries. Scouring in the damaged areas has reduced

crop production 15-30 percent on 10 to 15 percent of the floodplain. The large floodplains in the lower basin receive moderate scour damage. This seldom exceeds 15 percent damage on 10 percent of the floodplain.

Sediments are deposited in roadside ditches, ponds, and reservoirs and may cause damage where deposited on floodplain soil. When sediments are mainly silts and clays the economic damage to the soil is slight. Infertile sand deposits may reduce crop yields 10-15 percent. Most of the watersheds having sand deposits are located in the Chautauqua Hills.

The annual sediment yield from an area with typical land use is approximately 0.70 acre foot per square mile. (Exhibit 16) The average yield from good pastureland is less than 0.35 acre foot per square mile per year. About 70-95 percent of the sediments entering ponds and reservoirs are trapped thus shortening their useful life.

Land Treatment Needs - Conservation treatment currently is adequate on 35 percent of the 334,507 acres of cropland in land resource area 75. (Exhibit 17) Residue management, mainly minimum tillage, and terracing are the principal remaining land treatment practices needed. Minimum tillage is needed to retard deterioration of soil structure, to reduce soil compaction and formation of tillage pans, and to improve soil aeration, permeability, and tilth. Terraces are needed to conserve moisture and reduce erosion.

Treatment is adequate on 49 percent of the rangeland in land resource area 75. Proper grazing use is the most needed practice. This practice will result in increased vigor and reproduction of key plants, increased litter and mulch necessary to conserve soil and water, improved condition of the vegetation, increased forage production, maintenance of natural beauty, and reduced fire hazard. One percent of the rangeland needs improvement through deferred grazing to provide more efficient and uniform grazing.

The land treatment problems have been adequately solved on 49 percent of the cropland in land resource area 76. Terracing and minimum tillage are the most needed land treatment practices. Thirty-one percent of the cropland needs terracing and 15 percent still requires minimum tillage to be adequately treated. Contour farming is needed on 1 percent

of the area, drainage on 1 percent, and permanent cover on 3 percent.

Forty-eight percent of the rangeland in land resource area 76 has been adequately treated. Proper grazing use is needed on 475,346 acres and planned grazing systems on 39,098 acres. Brush control is needed on 398,877 acres in order to reduce competition of woody plants and establish a better cover for soil protection and forage production. Six percent of the rangeland requires range seeding before it can be used to its capacity, and 12 percent of that to be seeded requires brush control.

BRUSH CONTROL IS NEEDED ON MUCH OF THE RANGELAND IN CHAUTAUQUA COUNTY.

Land treatment measures have adequately solved the conservation problems on 27 percent of the cropland acres within land resource area 112. The application of terracing and residue management will provide adequate treatment on 68 percent of the area. Contour farming should be established on 16,745 acres and drainage provided for 3,045 acres.

One-third of all the rangeland in land resource area 112 is adequately treated. To be adequately treated, proper grazing use needs to be practiced on 21 percent of the rangeland. Brush control is needed on 131,280 acres. Ten percent

of the area requires range seeding and 36 percent of this needs brush control. Deferred grazing should be practiced on 14,641 acres.

Woodlands - The main deficiency in the unit's woodlands at present is not quantity of trees, but rather quantity of good trees. Management efforts are needed to bring woodlands up to their full commercial potential. While only about 5 percent of the commercial forest land requires complete reforestation, 1 acre in every 3 would benefit from partial or spot underplanting to fill in openings and improve species composition. About 50 percent of the forest land would benefit from stand improvement treatment, and 20 percent from harvest cutting. This means that a very small percentage of the unit's woodlands are not in need of treatment.

Grazing is practiced in much of the woodlands in the unit. Grazing causes soil compaction, loss of humus and litter, and seriously impairs the capacity of these woodlands to retard erosion and reduce peak runoff. It also reduces the economic potential of the woodland by reducing the reproduction of desirable species. Browsing soon removes the understory vegetation. Because of the competition for sun and soil moisture by the overstory, grass and forbs are sparse. Heavy grazing compacts the wet soil. Soon the woodlands offer the livestock little but shade.

Insects and disease cause losses in timber production through a reduction in growth, lower quality, deformities, and death. The occurrence of "Dutch-Elm" disease is only one of the problems causing concern. Such losses are greater than the annual harvest. More research into the control of forest insects is needed.

In some areas, herbicides have been used indiscriminantly on vegetation protecting steep slopes and in stands containing commercially valuable species. This practice reduces the ability of these areas to retard erosion and runoff and to realize their maximum potential for timber production.

To maintain or improve hydrologic conditions of the woodland sites, these areas must support vigorous, fully stocked stands of trees with undisturbed ground cover. Watershed benefits from woodland management and from proper land uses of forest sites will be sustained by realizing the

maximum economic returns consistent with site capabilities. To obtain these objectives land treatment measures including tree and shrub plantings, timber stand improvement, proper timber harvesting, grazing control, and fire control intensification are needed. To accomplish these forestry land treatment measures, technical assistance is provided by the Kansas State Extension Forester through cooperative agreement with the U.S. Forest Service.

Woodlands within the unit vary widely in hydrologic condition. A woodland-grassland cover, protected from grazing and fire, gives the most favorable hydrologic condition to a land area. This is due to its high interception capacity, high infiltration rate, high detention storage in litter and soil and high transpiration rate.

Many of the shelterbelts planted during the 1935 to 1955 period need improvement to re-establish or maintain their effectiveness. Those damaged by livestock need to be protected and replanted to close the gaps in the understory. Where overtopping and species dominance has restricted growth on desirable windbreak components, the offending trees should be removed.

Further analyses of shelterbelts are needed to determine the relative merits of these plantings. Land values are steadily increasing. With population growth, pressures mount for more food and forage production. The analyses of shelterbelts should include the aesthetic and wildlife values as well as the protection and product values of this type of land use in the basin.

A large percentage of the timber is located on bottomlands. These bottomlands are the primary source of trees and debris collected by flood flows and deposited in downstream log and brush jams. More intensive management is needed to maintain open floodways on bottomlands. This will require moderate grazing, removal of dead, cull, and weed trees; thinning of dense stands of trees; and pruning desirable crop trees. Trees left on the forest floor should be cut in short lengths with limbs removed in order to encourage rapid decay.

An intensive informational and demonstrational program is needed throughout the basin to acquaint people with woodland resource problems.

Watershed protection and management needs of woodlands in the Walnut-Verdigris Unit are quantified on page 223.

Floodwater and Sediment Damages

Floodplain damages discussed herein are those occurring on tributary streams of the unit. Mainstem Walnut and Verdigris River flood damages were not evaluated except where identifiable in the immediate vicinity of a tributary outlet. (Exhibit 18a)

One common characteristic of most streams of the unit is frequent flooding of extensively cultivated floodplain lands. Most streams experience flooding along some reaches more often than annually. Several of the tributary streams overflow as many as three or four times per year on the average. Generally, the lands most frequently flooded are devoid of improvements but are heavily cropped. Much of the upland in this area is grassland. The floodplain cropland constitutes an essential part of a balanced agriculture, therefore, flooding is a threat to the local economy. In addition, roads, bridges, fences, and farm buildings often sustain flood damages.

Most of the cities in the unit are situated on relatively high ground out of the reach of floodwaters. However, several cities are located partially in floodplains of tributary streams and have experienced flood damages in the past. These include Madison, Moline, Neal, Independence, Coffeyville, Eureka, Fredonia, and suburbs of Wichita.

Agricultural areas suffer the greatest flood damage. An estimated 262,848 acres along tributary streams are subject to inundation by a 100-year frequency flood (a flood which has a one percent chance of occurring in any given year). Some 208,144 acres of cropland, 18,848 acres of pasture, and 35,856 acres of miscellaneous use (including channel and adjoining timber) would be inundated by this size flood. (Exhibit 18)

Average annual crop and pasture damages based on 1980 projections are estimated to be $2,941,800. Other agricultural flood damages, including damage to stored grain and hay, fences, farm buildings, and farm machinery, average $349,400 annually. Damage caused by floods spreading noxious weeds such as Johnsongrass average $40,400 annually. Floodplain scour and sediment damages are estimated to average $558,500 annually on about 50,600 acres. Total average annual agricultural damage is estimated to be $3,890,100.

CROP AND LAND DAMAGE OCCURS ON THE UNPROTECTED OTTER CREEK FLOOD PLAIN IN GREENWOOD COUNTY.

Non-agricultural floodwater damage includes damage to roads, bridges, railroads, oil fields, and urban areas. Road and bridge damage is the major item in this category averaging $463,800 annually. Road and bridge damages occurring at crossings of upland draws and gullies were not evaluated but probably total more than that occurring along floodplains.

FLOOD DAMAGE TO ROAD IN GREENWOOD COUNTY

Railroad damage, which is relatively minor, averages $28,900 annually. Oil field damage is also minor totalling $11,200 annually. Average annual urban floodwater damage, totalling $30,200, was evaluated in the following towns: Windsor Park and Springdale (suburbs of Wichita), Madison, Neal, Moline, Independence, Coffeyville, Eureka, and Fredonia. Damages by flooding were primarily interruption of business, cleanup of sediment and debris, and loss in valuation of property. Total annual non-agricultural damages are estimated to average $534,100.

Indirect damage is estimated to average $434,300 annually. Indirect losses include interruption of transportation and utilities and loss of business to those serving agricultural communities.

Total evaluated tributary floodplain damages, including agricultural, non-agricultural, and indirect losses are estimated to average $4,858,500 annually.

Agricultural Water Management

Drainage - Natural and man-made dikes along some streams have interfered with surface water drainage. Drainage has also been a problem in localized areas of heavy bottomland soils. The Osage series is an example of a soil that is typically associated with poor drainage. Many of these problems have been solved by individual action. No widespread floodplain drainage problems requiring project type solution were encountered in this unit. The 1967 Conservation Needs Inventory places the remaining cropland drainage problem area size at 9,911 acres.

Irrigation Demands - Irrigation is not and probably will not be a large water user in this unit except in Cowley County. (Exhibits 26 and 31) This is due to rainfalls which normally range from 30 to 40 inches across the unit, low evapotranspiration rates, lack of adequate groundwater supplies or reliable surface water supplies, and the small amount of land suitable for irrigation. (Exhibits 6, 21, and 22) There is still a need for irrigation to stabilize farm income. (Exhibit 45) A small area towards the western edge of the unit has sufficient groundwater in combination with land suitable for irrigation. (Exhibit 20) Most of the irrigation in this unit will depend on surface water supplies. There are adequate surface water flows (Exhibit 6) and suitable reservoir sites in most areas to provide sufficient storage for irrigation. However, a

high level of management is required to irrigate profitably in this area. (Exhibit 47)

Most of the present irrigators are using water directly from streams. (Exhibit 21) They are having limited success because this source is unreliable without carry over storage. There are stabilized flows downstream from Toronto, Fall River, and Elk City Reservoirs but since there is no specific commitment for irrigation from this source, it cannot be depended upon for private irrigation during extended low flow periods.

There are quality problems with both ground and surface water, particularly in the western portion of the unit. (Exhibits 6 and 22) The surface water quality in central and eastern portions is satisfactory.

Rural Domestic and Livestock Water - The projected rural domestic water demands increase slightly while the livestock water demands increase about four times over the 50-year study period. (Exhibits 26 and 31) The rural population density of the unit ranges from 3 to 20 persons per square mile and is not expected to change much in the future. (Exhibit 27) Commercial feedlot development is expanding rapidly in the unit, particularly in Butler and Cowley Counties. (Exhibit 28)

The general discussion beginning on page 44 also applies to the character of livestock feeding operations in this unit.

Except for the extreme western portion of the unit, the groundwater supplies are generally inadequate for rural domestic and livestock needs and the surface water supplies are not reliable during droughts. (Exhibits 6, 19, and 22) There are quality problems, both with groundwater and surface water, in the Whitewater River area and in Wilson and Montgomery Counties. (Exhibits 6 and 22) There is a need for more rural water districts to supply rural domestic and livestock needs.

<u>Non-Agricultural Water Management</u>

Municipal and Industrial Water Needs - Most of the municipal development in this unit is and will be in Butler, Cowley, and Montgomery Counties. (Exhibits 26 and 31) The municipal and industrial supplies are from groundwater in

the southwestern portion of the unit and primarily from surface water in the northeastern section. (Exhibit 27) Except for the western counties the groundwater supplies are generally inadequate. There are some quality problems with the groundwater in the western portion. (Exhibit 22) Surface water will supply municipal and industrial needs when sufficient storage is provided. (Exhibit 6) More reservoir storage is needed to meet future municipal and industrial demands.

Industrial water demands are expected to increase steadily. (Exhibit 19) Most of the industrial water demand is for mining of oil and natural gas. There will be increased water demands for non-metallic mining, mostly sands and gravels, by the year 2020. It is anticipated that more and more of the industrial water demands will be met by municipalities and possibly by rural water districts.

Recreation - The recreation water needs are based strictly on the present and estimated future population in each county. Comparing available recreation areas with the demand within a single county may indicate a considerable deficit or surplus for that county. (Exhibit 29) However, adjoining counties may have a surplus or deficit which balances out over a multi-county area. For example, Wilson County shows a deficit for fishing at the present time, while adjoining Montgomery County shows a surplus in fishing supply because of Elk City Reservoir. (Exhibit 8)

There is a surplus of boating and fishing water in this unit because of the four existing major reservoirs - Elk City, Fall River, Toronto, and Winfield. (Exhibit 30) There are also numerous smaller reservoirs in the unit, making it one of the more desirable in the state from a water recreation standpoint. (Exhibit 8) Swimming is the only activity which shows a future need during the study period.

Fish and Wildlife - The general discussion beginning on page 47 applies to the fish and wildlife problems and needs in this unit.

There is a need for pollution control. Pollution does not limit fisheries over an entire stream system. Various forms of pollution (municipal, industrial, or feedlot runoff) exist locally and severely affect specific sections of the Walnut River, Grouse Creek, and Whitewater River.

Selective harvesting of fish causes changes in the dominant fish populations of existing lakes. A proper balance of fish populations is a necessity for maximum production. Constant management and annual surveys are required to maintain good quality fishing.

Pollution

The general discussion beginning on page 48 also applies to pollution problems in this unit. Fifty percent of the mean annual flow would provide more than enough water for pollution abatement needs in this unit were it to be all developed. (Exhibits 19, 28, 31, and 32)

Range and Forest Fires

Fire has been of considerable significance as a cause of watershed damage and deterioration. It was once a widespread custom in the timbered areas to burn the woods frequently. Most of the older timber stands show signs of past fire damage. With deterioration or destruction of the original plant cover, whether caused by fire or other watershed abuse, the resultant vegetation increases the fire hazard by providing flash fuels.

The major problem in controlling timber fires in the unit is the existence of areas of unburned logging slash. Additional effort is needed to reduce slash hazard, either through elimination of the slash or through increased utilization of the left-over materials.

About 1/4 of the fires result from debris burning. These are fires that are set on purpose but escape control. The creation of hazardous debris from reservoir clearing and other woodland activities continues to be one of the major fire control problems.

Railroads are a primary cause of fires. They have initiated tests of new spark arrestors, fuel, etc. Their efforts are presently being evaluated.

The major needs to improve fire control include:

1. Complete district and area fire planning.

2. Complete and/or update rural fire defense plans.

3. Measures to prevent fires from starting along roads in certain vulnerable areas.

4. Increase public awareness and action toward fire prevention.

5. A continuous updating and improvement of fire suppression facilities.

6. Reduce accumulation of hazardous fuels, such as logging slash, down logs, and dead trees.

7. Expand training program for volunteer fire groups with emphasis on selection of overhead personnel.

8. Increase communications equipment at the county level.

9. Complete long-range comprehensive planning with clear-cut objectives and goals in fire control.

10. Study legislation needed to improve fire protection.

11. Improve initial attack on fires caused by high hazard, fast burning fuels.

12. Reverse the trend in number of railroad caused fires.

Wildfires still destroy many acres of grassland and forest land each year. Although woodland fires in the basin are rarely hot enough to kill mature trees, the damage is greater and longer lasting than range fires. Litter and humus are destroyed, and seedlings and saplings are killed. Fire scars on older trees provide entry for insects and disease. The damage from insects and disease lower commercial value and shortens tree life. The complete rebuilding of humus and litter takes several years. The first few years after the fire, hydrologic condition is poor with increased surface runoff and erosion. Wildlife cover, including nests and burrows, is destroyed.

Significant damage from range fires is usually limited to improvements that are burned in the fire. Some forage is lost. Hydrologic condition is poorer. These conditions are temporary. New growth quickly restores forage and improves hydrologic conditions. The State of Kansas, through its Clarke-McNary Fire Protection Districts, protects state and private lands and assists federal agencies in their fire suppression activities.

Considerable progress has been made in extending protection to new areas and establishment of better protection in old areas. Accelerated fire control measures under the Cooperative Fire Program and the P.L. 566 projects should reduce the number of man-caused fires. Studies need to be made to determine adaptability of aerial attack methods to local conditions.

Following are the number of fires and acres burned by major cause for the five-year period 1963-1967 for protected state and private land in the Walnut-Verdigris Unit:

Item	Year					5-yr.
	1963	1964	1965	1966	1967	Ave.
No. of lightning-caused fires	1	4	3	9	13	6
No. of man-caused fires	1	114	170	545	487	263
Area burned 1/ - acres	370	8,875	4,021	39,174	55,443	21,577

1/ Includes organized rural fire districts only

In spite of potentially disastrous burning conditions in 1967, only 55,443 acres of forest and grasslands in the unit were burned. One large fire on January 24 and 25 accounted for 1,500 acres of this total. The number of fires in 1967 was 58 fewer than in 1966 although 16,269 acres more were burned. The number of fires and total area burned would have been more except for the fact that more land was under protection than in earlier years.

A large part of the success in controlling most fires is due to (1) the introduction of new techniques, including more widespread and aggressive fire prevention work (2) greater use of modern fire suppression equipment (3) improved

fire detection and radio communication, (4) use of improved national fire danger rating system, and (5) the recognition of high hazard areas from the study of past fire occurrence and fuel type maps. The improved fire prevention record has resulted in more healthy, young growing trees, but there is no room for complacency. Much timber is still being killed each year by fires.

Kansas State Extension Forestry personnel used the Mark II Fire Control Simulator in the unit in May and June of 1967 to present training to rural firemen on the initial attack of rural fires. Packets of fire prevention material are being distributed to all rural fire districts. Packets are also mailed to schools and various organizations on request by the State Extension Forester. Material is also supplied to radio stations and newspapers. The Keep Green and nationwide Smokey Bear Prevention Program are having their effect in making the public more aware of fire dangers. Continued effort is needed in on-the-ground contacts and instruction work to show people how they can safely use the resources.

Today many of the man-caused fire problems have been isolated to particularly heavy used recreation areas. The risk of fires will continue to mount because of the rapidly increasing numbers of recreation enthusiasts. Prevention or prompt suppression of range or timber fires is now and will continue to be an important facet of resource and watershed management.

Impairment of Natural Beauty

Sparse vegetation and severely eroded land mar the natural beauty of many areas of old oil field development. Oil field wastes spread by storm runoff have destroyed the soil holding vegetation and allowed gullying to occur. Extreme runoff events have caused overflow of sludge pits spreading oil downstream. In 1965 this problem was evident throughout the Walnut River valley.

Other water problems that reduce the natural beauty of the environment include: occasional droughts causing a browning of vegetation and dusty conditions; frequent floods carrying sediment and debris and drowning vegetation; and water carried pollution from agricultural, municipal, and industrial sources.

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Land Treatment

The general discussion beginning on page 53 also applies to programs for accomplishing land treatment in this unit.

In the Walnut-Verdigris Unit, the first soil conservation district was organized in Labette County in June 1938 and the last in Chautauqua County in February 1950. To date, 38 percent of the total cropland acres and 46 percent of the total rangeland acres have been adequately treated.

Upstream Watershed Projects

The general discussion beginning on page 53 also applies to watershed program provisions in this unit.

Watershed activity is more advanced in this unit than in any other part of the state.* (Exhibits 34 and 35) Twenty-one applications for assistance under P.L. 566 have been received and approved. These cover 2,612,902 acres or 60 percent of the unit. Disposition of these applications is as follows:

Watershed	Status	Area Acres
Muddy Creek	Completed	29,960
Bee Creek	"	45,360
Upper Verdigris	Authorized	210,860
Upper Fall River	"	200,001
Middle Caney	"	100,210
Twin Caney	"	98,370
Little Walnut-Hickory	"	171,510
Grant-Shanghai	"	25,200
Big Caney	"	228,000
Rock Creek	"	85,850
Timber Creek	"	101,700
Upper Elk River	"	138,800
Lower Elk River	"	130,440
North Sector Upper Walnut	In Planning	218,506
South Sector Upper Walnut	"	63,494

* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

Watershed	Status	Area Acres
East Sector Whitewater	In Planning	153,000
West Sector Whitewater	"	174,960
Duck Creek	"	42,320
Middle Walnut	"	182,131
Cedar Creek	Not Feasible	32,740
Walnut-West Creeks	Awaiting Planning	179,490
		2,612,902

Works of improvement included in the thirteen plans authorized for construction include land treatment, 284 single purpose floodwater retarding structures, 7 multiple-purpose structures, and 44.8 miles of channel improvement. Total storage in the 291 structures includes 53,183 acre feet for sediment reserve, 257,919 acre feet for detention, and 34,676 acre feet for water supply.

With planned land treatment and structural measures installed in the thirteen authorized watersheds, total average annual damages will be reduced by about 2 million dollars or 72 percent. About 116,500 acres of agricultural land within the projects will be benefited. Approximately 46,600 acres below the project outlets will also benefit. Three cities will receive flood protection. Multiple-purpose reservoirs will supply water to five cities with population totalling 20,302. Five authorized and three constructed Corps of Engineers reservoirs will also benefit through reduced flood and sediment storage requirements.

Construction in the authorized projects is well underway. The following progress was reported at the close of fiscal year 1970.

Item	Completed	Under Construction
Floodwater retarding structures	181	10
Multiple-purpose structures	4	2
Channel improvement (miles)	12.4	0

A COMPLETED WATERSHED DAM IN BIG CANEY WATERSHED, ELK COUNTY.

A significant test of the P.L. 566 projects was provided during the above average rainfall period of fiscal year 1969. Uncontrolled streams experienced far more severe flood damages than did neighboring watersheds where construction had progressed to a significant degree. Direct damage reduction benefits brought about by completed works were estimated to be $3,680,000. Total floodplain benefits to watershed construction were estimated at $4,880,000

Resource Conservation and Development Projects

The general discussion beginning on page 148 also applies to the resource conservation and development program in this unit.

The application has been approved for planning of the nine county See-Kan Resource and Development Project in southeast Kansas. A portion of the project area is included in this unit. Counties involved in the project are Cherokee, Labette, Montgomery, Wilson, Neosho, Crawford, Bourbon, Allen, and Woodson (see pages 13-14 for current RC&D status and basin area involved).

Flood Control Projects

Three Corps of Engineers reservoirs have been constructed within this unit. All are under jurisdiction of the Tulsa District. (Exhibit 34)

(1) Elk City Reservoir was placed into operation in July 1965. This $18.9 million project on Elk River contains 34,600 acre feet of conservation storage and 256,400 acre feet of flood storage. Normal pool surface area is 3,550 acres. Project purposes include flood control, water supply, and water quality control.

(2) Fall River Reservoir was completed in 1949 at a cost of $10.5 million. Operation of the reservoir serves a two-fold purpose: alleviation of flood damages and low stream flow augmentation. Flood control storage is 235,100 acre feet. Conservation storage totals 23,900 acre feet. Reservoir area at normal pool elevation is 2,450 acres.

(3) The $13.9 million Toronto Dam and Reservoir is located on the Verdigris River about four miles southeast of Toronto. Conservation and flood storages are 23,300 acre feet and 172,000 acre feet, respectively. The project was completed in 1960 for the purposes of flood control, low flow augmentation, supplementary water supply, and pollution abatement. The normal pool has a surface area of 2,800 acres.

Five additional projects have been authorized for construction in this unit. These are also under jurisdiction of the Corps of Engineers, Tulsa District. The projects and some details are:

(1) Big Hill Reservoir on Big Hill Creek in Labette County; estimated cost $4.6 million; flood control storage 12,600 acre feet; conservation pool 18,100 acre feet with 940 surface acres.

(2) Douglass Reservoir on Little Walnut Creek in Butler County; 76,400 acre feet of flood storage; 95,500 acre feet for conservation uses; estimated cost $20 million.

(3) El Dorado Reservoir in Butler County on Walnut River; estimated cost $25.6 million; 74,900 acre feet of conservation storage and 75,200 acre feet of flood storage.

(4) Towanda Reservoir on the Whitewater River in Butler County; flood control storage 133,500 acre feet; conservation storage 74,500 acre feet; estimated cost $25.5 million.

(5) Winfield Local Protection (1965 Modification) project includes improvement of existing levees at an estimated cost of $560,000.

Local protection levees were constructed at Winfield and Augusta in the middle 1930's by the Kansas Works Progress Administration. These projects are still functioning and provide partial flood protection to these cities.

Irrigation

Eighteen thousand acres of land in the unit were covered by irrigation water rights in 1959. Only about 1,600 acres were actually irrigated, probably because of a lack of good quality water at a reasonable cost. Current irrigated acreage is estimated at 6,500 acres. Surface water, directly from streams, is the primary water source of the 10,400 acre feet used annually. (Exhibits 19, 20, 21, and 22)

Drainage

There are three active drainage districts in this unit, all in Montgomery County. The three districts were organized in the period 1907-1909. They total 11,631 acres.

Water Supplies for Rural Domestic and Livestock Uses

Rural water districts have powers to develop water supplies or to contract with others in order to satisfy the rural water needs of an area. Financing of water supply systems is accomplished by loans through Farmers Home Administration. Thirty-two rural water districts have been organized in this unit as of June 1971. Information regarding these thirty-two districts is as follows:

Name	Year Organized	Number of Families Served	Status 6-1-71
Cowley County No. 1	1956	207	Operating
" " No. 2	1962	74	"
" " No. 3	1966	175	"
Butler County No. 1	1962	122	"
" " No. 2	1964	116	"
Sedgwick County No. 1	1967	200	Organized
Greenwood County No. 1	1966	214	Operating
Wilson County No. 1	1961	106	Operating
" " No. 2	1963	70	"
" " No. 3	1966	15	"
" " No. 4	1963	59	"
" " No. 5	1966	50	"
" " No. 6	1965	13	"
" " No. 7	1965	97	"
" " No. 9	1965	109	"
Neosho County No. 1	1962	8	Operating
" " No. 5	1965	26	"
" " No. 6	1965	71	"
Cherokee RWD	--	13	Operating
Montgomery County No. 1	1959	37	Operating
" " No. 2	1960	80	"
" " No. 3	1960	21	"
" " No. 4	1961	90	"
" " No. 5	1962	291	"
" " No. 6	1963	220	"
" " No. 7	1964	59	"
" " No. 8	1964	65	"
" " No. 9	1965	115	"
" " No.10	1966	41	"
" " No.11	--	44	Organized
Labette County No. 3	1965	57	Operating
" " No. 7	1967	49	"

The bulk of these rural water districts obtain water from cities. Only a few lakes are being used for self-supplied rural water districts at the present time.

Municipal and Industrial Water Use

About 81 percent of the unit population served by municipal systems utilize surface water supplies (Exhibit 27)

The cities of Edna, Eureka, Howard, Moline, Sedan, Severy, Augusta, and El Dorado obtain all or part of their water from city lakes. Other surface supplies are directly from streams. The cities of Madison, Eureka, Sedan, Winfield, and Caney also have new water supplies from multiple-purpose watershed structures.

WINFIELD RESERVOIR IN COWLEY COUNTY PROVIDES FLOOD CONTROL, CITY WATER SUPPLY, AND RECREATION.

Municipal and industrial water storage is provided in the recently completed Elk City Reservoir. Other authorized reservoirs, yet to be constructed, that include water supply reserve are Towanda, El Dorado, Douglass, and Big Hill.

Although most industries in the unit obtain water from municipal systems, a substantial number have their own supplies. About 80 percent of industrial water rights are for surface sources.

Recreation

The general discussion of the Land and Water Conservation Fund Act, beginning on page 56, also applies to this unit.

Among the water areas available for recreation use in this unit are Elk City Reservoir, Fall River Reservoir, Toronto Reservoir, six state lakes, several municipal, industrial, and private reservoirs, and overflow dams and many private farm ponds.

The P.L. 566 watershed program provides many reservoirs for recreation use, both as a specific purpose and incidental to flood control. One privately operated reservoir in the Cáney watershed system has proven popular on a fee basis. The Boy Scouts of America, Quivira Council, donated easements for and shared in the construction cost of one site in Twin Caney Watershed. Permanent storage was added to their site to provide a lake to serve for seven separate wilderness camp sites. The SeKan Council, Boy Scouts of America, also obtained a council camping area in Bee Creek, using the sediment pool of the pilot watershed reservoir for their aquatic program. Multiple-purpose structures sponsored and cost shared in by the cities of Sedan, Caney, and Winfield are providing new recreational opportunities for residents in that area. Many visitor days of recreation have been realized incidental to sediment pools in the nearly 300 floodwater retarding structures already constructed in this unit. Multiple-purpose reservoirs under construction in Upper Verdigris and Fall River Watersheds are soon to be added to this growing list of recreational opportunities.

BOY SCOUTS HAVE A CAMP ON A WATERSHED RESERVOIR IN CHAUTAUQUA COUNTY.

Capacities, surface areas, and drainage areas of lakes for which information is available are as follows:

Name	Capacity[1/] acre feet	Surface Area acres	Drainage Area sq.mi.
Elk City Reservoir	60,300	4,400	634.0
Fall River Reservoir	23,900	2,600	585.0
Toronto Reservoir	23,300	2,800	730.0
Augusta City Lake	1,820	182	7.8
Augusta City Lake (Elm Creek)	--	192	8.0
Edna City Lake	100	11	0.2
El Dorado (Lake El Dorado)	3,213	284	33.0
El Dorado (Lake Bluestem)	10,620	845	48.6
Eureka City Lake	3,690	259	15.3
Howard City Lake	730	68	10.1
Moline (1 mile west)	115	23	4.7
Moline (2 miles southwest)	236	25	0.5
Sedan City Lake	660	55	5.7
Severy City Lake	70	20	2.0
Santa Fe Lake	1,610	232	40.0
Butler County State Lake No. 2	1,060	124	7.6
Cowley County State Lake	1,280	80	7.1
Montgomery County State Lake	1,000	105	6.3
Wilson County State Lake	1,940	119	10.2
Woodson County State Lake	3,210	179	6.2
Murray Gill Lake (Twin Caney No. 18-26)	9,572	473	26.8
Caney Lake (Twin Caney No. 2-6)	854	90	6.03
Sedan Lake (Middle Caney No. 6-28)	780	74	7.03
Madison Lake (Upper Verdigris No. 7-8)	1,357	114	3.91
Eureka Lake (Fall River No. W-7)	5,845	259	14.2
Winfield Lake (Timber Creek No. 29)	19,812	1,131	64.2[2/]
Accumulated total for 191 completed single-purpose floodwater retarding structures	24,347[3/]	4,294[3/]	815.98

1/ Excludes flood control
2/ Includes 18 floodwater retarding structures above controlling 29.26 square miles
3/ Sediment pools

Fish and Wildlife

Forestry, Fish and Game Commission biologists conduct surveys and evaluate fish and wildlife within the unit on an annual basis. Fish stocking and rehabilitation programs are initiated when needed and when funds are available.

The Forestry, Fish and Game Commission has recently transplanted wild Rio-Grande turkeys in the unit with limited success. (Exhibit 10)

The Forestry, Fish and Game Commission has designated three areas containing approximately 25,218 acres as public hunting areas. These areas around Elk City, Fall River, and Toronto Reservoirs are leased from the U.S. Corps of Engineers. (Exhibit 8)

Cooperative State-Federal Forestry Programs

Because the public has a large stake in all forest and non-forest watershed lands, both public and private, the federal government cooperates with the states and private landowners to improve protection and management of these lands. Forestry assistance includes tree planting, forest management, fire and watershed protection, and marketing and utilization of forest products.

In these programs the U.S. Forest Service works directly with the Kansas State Extension Forester under a partnership agreement. Actual work is carried out through various cooperative programs. The Extension Forester does the actual work and administers the program on state and private lands. The Forest Service allots federal funds and provides counsel on all phases of the programs. The costs of the projects are shared by each partner. The federal government can provide 50 percent matching funds for the major programs.

The major forestry programs in the unit are (1) Cooperative Forest Management, (2) Cooperative Tree Planting, and (3) Cooperative Fire Control. Another major program is the Cooperative Watershed Program, for which 100 percent matching funds may be provided.

Cooperative Forest Management - The U.S. Forest Service administers the Cooperative Forest Management Program. It is

responsible for coordination of program phases, review and approval of financial plans, and determination and review of program standards.

The State Extension Forester is responsible for administration and supervision of cooperative work. This involves planning and developing the program, hiring, training, equipping men and making all expenditures incident to the program. The importance of the Cooperative Forest Management Program stems from the fact that 100 percent of the unit's commercial forest land is in private ownership. The majority of the small tracts of private commercial forest land is in urgent need of management to meet future demands for wood.

The Forestry Program assists private landowners to improve management and develop multi-purpose uses of their woodlands. Assistance also is available to private landowners and processors in marketing and utilization of timber and forest products.

The State Extension Forester and his staff offer on-the-ground technical assistance to the individual private landowner. The Forest Service, in cooperation with the State Extension Forester, may work directly with universities, large landowners, wood-using industries, and other state, federal, and private agencies on major problems.

Timber surveys reveal the changes that have occurred and the trends that have developed since the last survey. They also point out obvious opportunities for increasing forest productivity.

Cooperative Tree Planting - It is in the public interest to protect, restock, and maintain the productivity of forest lands. Several federal programs authorize the Forest Service to cooperate with state forestry departments and private landowners in reforesting their lands. The three major programs are:

1. Cooperative distribution of planting stock
2. Soil Bank
3. Forestation assistance to states

The Clarke-McNary Act of 1924 (Section IV) gives the Forest Service authority to cooperate with the states in

growing and distributing forest tree seeds and planting stock. Federal assistance to state, both technical and financial, is authorized.

The program contains an incentive to distribute trees for windbreaks, shelterbelts, and woodland plantings at the lowest possible prices. The ultimate objective, of course, is to stimulate tree planting by providing stock at prices so low that any landowner can afford planting stock.

The unit has a long history of tree planting. The Shelterbelt or Prairie States Forestry Project started in 1935, assisting farmers and ranchers in planning and establishing windbreak systems on croplands. Plantings have continued through the present with assistance from federal and state cooperative programs. During the past three years 1,225,000 trees have been planted for windbreak purposes.

Tree seedling sales have declined in recent years due to the conversion of multi-row shelterbelts to single-row belts and abandonment of farmsteads.

Investigations of shelterbelt improvement techniques are currently conducted by the Rocky Mountain Forest and Range Experiment Station in cooperation with Kansas State University.

Cooperative Fire Control - The purpose of the Cooperative Fire Control Program is to provide permanent protection of non-federal timbered, potential timbered, and certain non-forested lands. The State Extension Forester assists each county in making fire plans, purchasing equipment, organizing firefighters, and training manpower. Technical assistance is also furnished by the State Extension Forester's office.

The Forest Service (Division of State and Private Forestry) (1) works with the State Extension Forester, giving technical advice in planning and managing fire programs, (2) keeps informed on new developments in research and passes information on to the State Extension Forester, (3) assists the state in procuring of surplus property suitable for the Fire Control Program, (4) assists in making area and cost studies and trains state personnel in damage appraisals, and (5) assists the state in providing fire training for their personnel.

Under the Cooperative Fire Control (C-M 2) Law, the Forest Service can match state and private expenditures up to 50 percent limited by the amount of federal lands available.

Under the Clarke-McNary Act, the states and federal government have joined to do a better job of fire control on non-federal lands. The two public agencies are active partners in jointly financed enterprise. The actual administration of the Cooperative Fire Control Program and direct responsibility for supervising and handling the job rests with the states.

Cooperative Watershed Protection and Flood Prevention - Under this program, private landowners, the states, and federal agencies work together on a project basis to improve the protection and management of the water and land resources. The State Extension Forester may provide technical assistance to private landowners in project areas suited to forestry. This may include fire protection, timber stand improvements, tree planting, watershed rehabilitation improvements, and pest control.

It is the responsibility of the Forest Service to, (1) insure that all forestry aspects of U.S.D.A. programs (without regard to landownership or administration) are technically adequate, (2) to encourage and assist the State Extension Forester to take part in programs when non-federal lands are involved, and (3) to provide policies and procedures for developing the forestry phases of the program.

Cooperative Forest Insect and Disease Control - The objective of the Cooperative Insect and Disease Control Program is to detect, evaluate and suppress insect and disease outbreaks on state and private lands before they become a serious widespread infestation. The State of Kansas is not cooperating in this program.

Forestry Research - The McSweeny-McNary Act, passed in 1928, provides a broad charter for forest research programs. Under its provisions the U.S. Forest Service operates regional forest and range experiment stations to serve the principal forest regions of the nation. The unit is located within the boundary of the Rocky Mountain Forest and Range Experiment Station headquartered in Fort Collins, Colorado. Here research is on forest insects, forest

diseases, forest genetics, range and wildlife habitat, watershed management, forest fires, recreation, forest products utilization, shelterbelt establishment, and management and engineering.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Land Use and Conservation Treatment

Land treatment measures have been installed on 38 percent of the cropland area. Residue management and terracing are the major conservation needs for the cropland farming area. Permanent cover should be established on approximately 14,659 acres. Nearly one-half of the rangeland has received adequate conservation treatment. The principal measures needed to complete treatment of the rangeland are proper grazing use, range seeding, and brush control.

A large part of the unit's woodlands are on sites capable of excellent timber growth--over two-thirds are rich bottomland and side drainage sites. However, only one acre out of three is adequately stocked at present.

It is reasonable to project that about 71 percent of the cropland treatment needs and about 82 percent of the rangeland treatment needs can be accomplished by the year 2000. Projections assume continuation of current incentive programs and are based upon established trends.

Upstream Impoundment Sites

Most of the unit has excellent potential for floodwater retarding structure sites. This fact is evidenced by the advanced stage of P.L. 566 development in the unit. It is usually desirable to locate sites as close as possible to primary damage areas for maximum damage reduction. This goal is attainable in most watersheds of the unit.

The Flint Hills area offers many sites in rugged pastureland close to cropland floodplain. The Walnut River and lower Verdigris portions are more gently rolling and offer less site potential with more encroachment on cropland. (Exhibit 36)

Nearly 1,500 physically possible floodwater retarding structure sites were examined in this unit. About 75 percent of sites studied have average or better floodwater retarding storage characteristics. Sites classified as below average in floodwater storage potential were found mainly in rugged areas of the Flint Hills. Sites of this category are expensive because valleys are narrow and high dams are required to meet floodwater storage requirements. Rock is usually involved in emergency spillway excavations. These sites are still desirable in spite of their relatively high cost because large drainage areas can be controlled without encroaching on cropland.

Over 800 of the structure sites studied are included in watersheds that are already in P.L. 566 planning status or beyond. Many of these have been constructed. The 652 sites studied in watersheds that have not reached planning status show much the same potential storage characteristics as those already planned. One half of the sites have drainage areas in the range of 1 to 3 square miles. Another 25 percent fall in the 3 to 6 square mile range. Fifteen percent range from 6 to 12 square miles. Few are less than 1 square mile or over 20.

Total drainage area controlled by sites investigated is 2,312 square miles or 34 percent of the unit area. 1,619 square miles or 70 percent of this amount is included in watersheds in planning status or beyond. Some sites are in series. Sites were not studied on the mainstem Walnut or Verdigris Rivers. Sites studied did not exceed maximum size limitations under P.L. 566.

High value floodplain, frequently damaged, added to the strong site potential makes this unit highly adaptable to the small watershed program. Protection of crops grown on these floodplains is essential because they are an important part of a balanced agriculture.

<u>Channel Work</u>

Streams in the unit generally have relatively large channels, often bedded in rock. This fact usually negates the need of channel improvement to supplement land treatment and floodwater retarding structures for flood control. There are a few exceptions. Channel improvement does have potential in Middle Walnut which is now in planning. Some channels in this watershed are too small to carry structure

release and uncontrolled flows from more frequently occurring storms.

Agricultural Water Management

Storage - Irrigation storage in this unit is generally that required to meet supplemental water needs. Physical potential exists for irrigation storage in most watersheds of the unit. Sites in more than three-fourths of the watersheds have average or above average water supply storage characteristics. Yields are generally adequate to fill carry-over storages.

Excellent potential for rural domestic and livestock water supply storage is found in this unit. Nearly all watersheds have some potential water supply storage capability. Reservoir sites were found in all areas of critical need. To economically utilize this potential many users should be tied to a single reservoir. Rural water districts have the power to implement projects of this nature with funds loaned by Farmers Home Administration.

Groundwater recharge from surface storage is not feasible in this unit. Subsurface conditions will not allow water in appreciable quantities to reach the limited aquifers that are encountered throughout most of the unit.

One hundred thirty sites were recognized to have some degree of physical potential for multiple-purpose development including, if needed, agricultural water storage. About one-third of the sites were found to have above average water storage characteristics. Sites with promising physical potential were found in all parts of the unit. (Exhibit 37)

Drainage - Problems noted in this study are too scattered for project type solutions. It is reasonable to assume that nearly all of the remaining drainage needs can be solved through individual on-farm action by the year 2000.

Non-Agricultural Water Management

Multiple-purpose sites are available to provide municipal-industrial water storage wherever needed in this unit. Three-fourths of these sites have average or above average municipal-

industrial storage potential. The best physical sites are found in rolling to steeply rolling areas of the central portion of the unit. Yields are generally more capable of replenishing carry-over storage volumes in the eastern part of the unit. (Exhibit 37)

Physical opportunities for development of multiple-purpose reservoirs including recreation or fish and wildlife storage are plentiful in this unit. Sites with deep storage are most desirable. Recreation sites are enhanced by their scenic surroundings. Fish and wildlife developments in the many tree-lined valleys would offer favorable habitat for the edge creatures that abound in this unit.

Water Quality Control - The general discussion beginning on page 63 also applies to potential development of water supplies for water quality control in this unit.

Availability of Land and Water for Potential Development

The 130 reservoir sites recognized as having multiple-purpose development potential have a storage capability of 142,000 acre feet. Yield will not limit this potential. This volume is above the sediment and flood water storage reserves that would be necessary for single purpose development. Water quality in impoundments will be adequate for most uses.

Cropland would be involved in development of the full storage potential of many sites. Nearly all of the land involved is in private ownership. The possibility of encroachment on roads, farmsteads, or pipelines increases as storage is increased in most sites. Railroads or highways would be involved in a very few cases. Towns would not be affected by any of these sites. Other larger sites not investigated are likely to involve more serious encroachment on physical improvements.

WALNUT-VERDIGRIS UNIT

OPPORTUNITIES FOR DEVELOPMENT WITH USDA PROGRAMS

Land Treatment Measures

The general discussion beginning on page 65 also applies to opportunities for development of land treatment in this unit with the exception of the Great Plains Conservation Program.

The total cost of installing the needed land treatment measures listed in Exhibit 17 for the Walnut-Verdigris Unit is estimated at $21,000,000.

Upstream Watershed Projects

The general discussion beginning on page 66 also applies to opportunities for P.L. 566 development in this unit.

Early Action Projects - Two upstream watersheds within the Walnut-Verdigris Unit were found to be feasible and needed within the next 10-15 years. These are in addition to watershed projects that have already reached planning status or beyond.

Watershed Name	CNI No.	CNI Drainage Area Acres
Chetopa Creek	1s-10	37,525
Onion Creek	1s-19	73,751
Total		111,276

These two watersheds include 111,276 acres or 2.5 percent of the Walnut-Verdigris Unit. These two added to the nineteen that already have attained planning status under P.L. 566 total 21 feasible watersheds covering 2,511,948 acres or 57.4 percent of the unit.

It would be possible to economically control about 68 square miles or 39 percent of the area included in the two

feasible watersheds. These figures are based upon an estimate of the physical, economic, and social aspects of each watershed. Local interests may have valid reasons for variation from systems selected for this study. Any variation from the systems for which data is summarized in this report would produce different physical and economic values.

The 68 square miles of control can be accomplished by installation of 11 reservoirs. It is estimated that nine of these sites will be single purpose floodwater retarding structures and two will be multiple-purpose floodwater retarding and recreation structures. Total storage capacity of the 11 structures will include: sediment, 3,493 acre feet; detention, 16,825 acre feet; and other, 2,420 acre feet. Other storage includes municipal water, agricultural water, and recreation. Surface area totals are: sediment pools of single purpose floodwater retarding structures; 228 acres; permanent pools of multiple-purpose floodwater retarding and recreation structures, 422 acres; and detention pools (all structures), 1,860 acres. (Exhibit 39)

Channel improvement was not included as a measure to supplement floodwater retarding structures in either of the two feasible watersheds. Lack of physical or economic feasibility were primary reasons for not adding channel improvement to obtain additional damage reduction benefits. More detailed study in work plan development may show isolated cases of feasibility for this measure.

Long Range Projects - There are seventeen additional watersheds that merit future consideration for project development. At present these projects are not economically feasible because of high interest rates, high costs, and evaluation procedures. These projects should be re-evaluated if any favorable changes occur in evaluation factors. This group of projects includes 2,083 square miles, 29 percent of which could be reservoired by 75 structures. Total storage capacity would probably include: sediment, 26,926 acre feet; detention, 122,657 acre feet; and other, 7,591 acre feet. Surface area totals are: sediment pools of floodwater retarding structures, 2,159 acres; permanent pools of multiple-purpose structures including recreation storage, 1,499 acres; detention pools (all structures), 12,172 acres.

Cooperative State-Federal Forestry Programs

Seedling trees are needed for reforestation and wind barriers. There is opportunity to bring approximately 79,500 acres into forestry production by tree planting. Species composition may be improved by planting and seeding. Most of the past planting has been done by private individuals. It is estimated that 35,000,000 trees will be needed for reforestation and wind barriers. The following table lists estimated land treatment measures proposed on state and private forest lands in the Walnut-Verdigris Unit, to 1980 (estimated cost - $8,195,500):

Item	Unit	Amount
Timber surveys	Acres	174,000
Forest management (technical assistance) timber thinning, pruning, and releasing	Acres	93,800
Growing and distribution of seedling trees for reforestation and wind barriers	Trees	35,000,000
Tree planting and seeding	Acres	79,500
Insect and disease control program	Acres	20,000
Fire control programs	Acres	79,500
Cooperative watershed protection and flood prevention	Acres	254,000

Increased interest in forest management is expected to improve timber quality and quantity by the year 2020. The quantity of timber and the productive capacity of the forests indicate a good future for the forest industry. Lumber production is expected to triple by 2020. Demand for hardwood pulp is increasing each year. A pulp and paper mill in the unit could utilize much of the pulpwood now unused.

Resource Conservation and Development Projects

A portion of the See-Kan Resource Conservation and Development Project is in this unit. This project has been approved for planning. Broad objectives of the project are orderly development of natural resources, establishment of a more balanced economic base, and improvement of the total environment.

Rural Water Districts

Groundwater supplies are generally inadequate for rural domestic and livestock needs in this unit. There is considerable opportunity for development of more rural water districts. (Exhibits 22 and 27)

Although there is potential for use of watershed structures as a source of supply for rural water districts, it appears that the trend is to utilize an existing municipal supply. There is a question as to whether some municipal systems now being expanded to include rural water districts can maintain adequate supplies during severe drought periods. There are towns now supplying rural water districts which have had shortages in the recent past.

Rural Electrification Administration

The discussion on page 69 also applies to the Rural Electrification Administration Program in this unit.

IMPACT OF USDA PROGRAMS

Land Treatment Measures

The economy of the Walnut-Verdigris Unit is dependent on agriculture. Application of the needed land treatment measures listed in Exhibit 17 will increase crop and livestock production and have a direct effect on the economy.

Land treatment measures such as residue management and terracing will reduce erosion and sediment yield and allow better use of precipitation. Proper grazing use, brush control, and range seeding will increase forage production resulting in increased livestock production and improve natural beauty of the grazing lands.

RANGE SEEDING, AS SHOWN IN ELK COUNTY, IS AN IMPORTANT CONSERVATION PRACTICE IN THE WALNUT-VERDIGRIS UNIT.

Land treatment benefits in this unit, from flood reduction in planned watershed projects and those authorized for planning or recommended as early action projects, are $172,000 annually.

Upstream Watershed Projects

The discussion beginning on page 70 also applies to the general impact of watershed development in this unit.

Existing Projects - Floodwater and sediment damages will be reduced to a varying degree for 154,629 acres of floodplain upon completion of the 19 existing projects. (Exhibit 18) Existing projects include those having attained the status of planning authorization or beyond. Average annual damages will be reduced some 65 percent by these projects. (Exhibit 40)

CROP AND LAND DAMAGE SUCH AS THIS WILL BE GREATLY REDUCED BY INSTALLATION OF ROCK CREEK WATERSHED.

Total expected benefits are as follows:

Flood Damage Reduction	$2,218,900[1/]
Recreation (as a purpose)	287,300
Other[2/]	137,400
Land Enhancement	434,900
Off-Project	434,800
Local Secondary	237,100
Total	$3,750,400

1/ Includes $160,900 benefits from land treatment
2/ Includes benefits to M&I, sediment reduction of mainstem reservoirs, mainstem floodplain, and EDA benefits to local labor.

Average annual cost of structural measures included in existing projects totals $2,082,900. Comparing total benefits to total costs produces a ratio of 1.8:1 for these 19 projects.

Early Action Projects - Installation of works of improvement, under P.L. 566, in the two feasible early action projects will directly benefit 8,615 acres of floodplain lands within the watershed areas. (Exhibit 18) In addition, the works of improvement will provide benefits to downstream floodplain, outside the watershed boundaries.

It is estimated that average annual floodplain damages can be reduced 47 percent through installation of land treatment and structural measures in the two watersheds. This reduction can be accomplished with a physically and economically feasible system in each watershed. Effects of one such possible system for each watershed are summarized in this report. (Exhibit 41)

Average annual benefits for the two watersheds are: flood damage reduction, $70,300, of which $4,400 is to land treatment and $65,900 to structural measures; recreation (incidental and as a purpose), $40,000; land enhancement, $4,300; off project, $14,100; other, $6,100; and local secondary, $11,700; for a total of $146,500.

Average annual cost of structural measures to be installed in early action projects is $141,900. The

ratio of total benefits to total costs for these two projects is 1.2:1.

Recreation benefits were evaluated for those structures for which estimated costs include storage for recreation use. Two of the reservoirs fall into this category. Combined surface area of recreation pools is estimated to be 422 acres.

Long Range Projects - Seventeen additional watershed projects including 1,810 square miles may someday become economically feasible. These projects would benefit 77,902 acres of floodplain land. Total average annual benefit and cost figures for these projects are:

Benefits	$767,700
Costs	$852,300
Benefit-Cost Ratio	0.9:1

Forest and Grassland Management Programs

Forest management is aimed at increasing timber production and other forest values through good forestry planning and practices. The production condition of stands that are less than saw-log size will improve substantially by thinning and pruning. Removal of cull and defective trees and trees of poor species, form, and vigor will give thrifty crop trees more growing space. A mature, fully stocked, commercial forest site, under a system of intensive management, will support 5 to 10 times the present volume.

In addition to timber production, woodland improvements can make very real contributions in terms of recreation, scenic, and wildlife benefits. In many areas these multiple-benefits may in the long run outweigh the value of woodlands for timber production.

Forest management will help develop a protective cover during heavy rains. Tree cover aids in retarding runoff and reducing soil losses and sediment to a minimum.

Trees have an effect on the extremes of climate, protecting against excessive heat and cold. Trees help prevent flooding, erosion, and sedimentation. Their transpiration

may improve atmospheric conditions during periods when the humidity would otherwise be low. Trees screen out dust and act as windbreaks and sound barriers. Their aesthetic values influence mental health.

Many farmsteads would benefit from windbreak, pond, or wildlife plantings. Properly planned and placed plantings of this nature will add materially farm or ranch value.

The number of people employed in timber-based industries is expected to rise from 240 in 1965 to 740 by the year 2020. (Exhibit 42) These estimates are based upon increases in the output per man-day and anticipated timber to be cut.

Resource Conservation and Development Projects

The general discussion of intangible benefits beginning on page 169 also applies to the impact of resource conservation and development project development in this unit. Monetary benefits of the See-Kan project are currently being evaluated.

Rural Water Districts

The general discussion beginning on page 170 also applies to the impact of rural water districts in this unit.

NEOSHO UNIT

Land Use -	Cropland	-	1,797,190 acres
	Rangeland	-	1,610,540 acres
	Forest	-	257,500 acres
	Other	-	376,170 acres
Total Area		-	4,041,400 acres

Total Capability Class I, II, III, and IV Land - 3,144,600 acres (78%)

Irrigated Acreage - 3,200 acres (1971)

Average Annual Precipitation - 30 to 42 inches

Land treatment is adequate on 573,500 acres of cropland (32%) and 765,900 acres of rangeland (48%)

The total cost of applying needed crop and pasture land treatment is estimated to be $24,000,000

The total cost of applying needed forest land treatment is estimated to be $7,935,200

Floodwater and sediment damages on tributary streams average $5,450,700 annually--some 292,500 acres are subject to inundation

P.L. 566 Watershed Projects Completed or Authorized for Construction - One

Active P.L. 566 Watershed Projects Authorized for Planning - One

Twenty-one feasible Early Action watershed projects are needed within the next 10-15 years

Sixteen additional watersheds merit consideration for Long Range project development

NEOSHO UNIT

NATURAL RESOURCES

Location and Size

The Neosho Unit is a long, narrow, irregular shaped area at the extreme eastern end of the Arkansas Basin in Kansas. This 4,041,440 acre (6,315 square miles) area constitutes about 15 percent of the basin. Major streams are the Neosho, Cottonwood, and Spring Rivers. The Neosho joins the Arkansas River in east-central Oklahoma. The drainage areas of the major rivers in Kansas are:

Name	Area in Square Miles
Cottonwood River	1,907
Neosho River	3,955
Spring River	453
Total	6,315

Cherokee is the only county entirely within the unit. Counties partly included are McPherson, Harvey, Marion, Butler, Chase, Morris, Wabaunsee, Lyon, Greenwood, Coffey, Woodson, Anderson, Allen, Wilson, Neosho, Labette, Bourbon, and Crawford. (Exhibit 1)

Climate

Climate is divided into two main classifications with the transition occurring near the middle of the unit in Coffey County. The upper or northwest portion is subhumid continental. Lower reaches are humid continental. Warm, moist air masses moving northward from the Gulf interact with surges of cooler, drier air from the north to produce heavy precipitation. Frequency of moist air flow is greater in extreme southeast Kansas than in any other part of the state. Therefore, the Neosho Unit includes the wettest area in Kansas. Other characteristics include warm to hot summers, generally mild winters, moderate to high humidity, light to moderate winds, and low annual snowfall.

Mean annual precipitation ranges from 30 inches in Marion County to 42 inches in Cherokee County. (Exhibit 2)

Precipitation varies considerably from month to month and from year to year. Records at Pittsburg for the period 1913-1966 show annual precipitation ranged from 21.50 inches in 1963 to 63.11 inches in 1941. It is not unusual for wet and dry years to alternate. The wet year of 1951 (56.69 inches) was followed by a dry year (25.32 inches). Droughts of several years duration seldom occur in southeastern portions of the unit but may very well occur in the upper Neosho and Cottonwood portion.

Usually three-fourths of the annual precipitation occurs during the seven month period, April through October. Seasonal distribution of rainfall favors growth of crops and grasses. Average monthly precipitation at Pittsburg exceeds two inches in all months but January, February, and December. Heaviest precipitation is in June with a normal of 5.7 inches. In periods when rainfall is heaviest, much of it comes as showers and thunderstorms.

Annual snowfall normally amounts to 12 to 18 inches. Snow cover usually lasts only a few days. Short duration blizzards sometimes occur.

Average annual lake evaporation ranges from 46 to 54 inches in this unit. Two years out of 100, normal lake evaporation will be exceeded by approximately 30 percent.

Temperature variations are typical of mid-latitude, continental locations. Mean monthly temperatures at Columbus in Cherokee County range from 34 degrees in January to 79 degrees in July and August. Temperature extremes for the period of weather records at Columbus are -28 degrees F and 117 degrees F. Recorded temperatures at Columbus are representative of other stations in the unit. Average length of frost-free period ranges from 178 days in Chase County to 198 days in Labette County. Freezing temperatures at Burlington were recorded as late as May 9 and as early as September 26.

Topography

The Neosho Unit is chiefly in the Osage Plains section of the Central Lowlands physiographic province. The unit also includes a small part of the Flint Hills Upland in Morris, Marion, and Chase Counties and the Cherokee Lowlands

in Cherokee and Crawford Counties. About fifty square miles of the Ozark Plateau Province is exposed in the southeast corner of Cherokee County.

The major topographic feature is the Neosho River valley trending southeast through the unit. Rolling hills and low cuestas are formed on the upland. These are shaped by differential erosion of limestone, sandstone, and shale.

THIS SCENE ALONG THE MEANDERING NEOSHO RIVER IN MORRIS COUNTY IS TYPICAL OF THE NEOSHO BOTTOMLAND.

The relief is greatest in the northwest and becomes more gentle when approaching the lower reaches. The highest point on the northwest perimeter is about 1,480 feet. The lowest point is 770 feet at the Oklahoma line.

The tributary streams are deeply entrenched. The floodplains average less than one-half mile wide. The lower floodplain of the Neosho River is quite flat with an average width of two to three miles.

Geology and Soils

Sedimentary rocks of Cambrian-Ordovician, Silurian-Devonian, Mississippian, Pennsylvanian, Permian, and Quaternary ages overlie the Precambrian basement complex. The total thickness is 3,000 to 4,000 feet. The exposed rocks are of Lower and Upper Mississippian, Lower Permian, Middle and Upper Pennsylvanian, and Quaternary ages. The dip is west-northwest at 15-20 feet per mile.

The Cherokee Group of sandstones and sandy shale of Middle Permian age is exposed in the Cherokee Lowland. Coal beds are present in this formation.

Very thick limestone strata with interbedded shales of the Kansas City and Lansing Group are exposed over most of Allen and Neosho Counties. The Douglas Group of sandstone, sandy shales, and silty shales occupy parts of Allen and Woodson Counties and the southeast corner of Coffey County. Limestones and sandstones cover most of Coffey County.

Thin limestones and thick shales of the Wabaunsee Group are exposed in Lyon County. The Council Grove and Chase Groups with thick cherty limestones in Chase, Morris, and part of Marion and Lyon Counties help form the Flint Hills. The Sumner Group of shales and siltstones occurs in western Marion County.

The parent materials of soils on upland are predominantly shale, limestone, and sandstone. On the nearly level to sloping upland are moderately deep to deep, clayey soils. (Exhibit 3) They are moderately well drained to well drained. Claypan soils occur in some of the nearly level and gently sloping areas. In the southeast part of the unit the nearly level soils are predominantly claypans. Throughout the unit the steep slopes are occupied by moderately deep to shallow, loamy soils. Rock outcrops are common on the steep slopes. The soilson bottomland are loamy to clayey. They are deep soils and range from poorly drained to well drained.

Minerals

Oil and gas is economically important to the basin. Millionsof dollars worth of oil have been produced since the turn of the century. Oil and gas fields are located in

Neosho, Allen, Woodson, and the southeast corner of Coffey Counties. (Exhibit 4)

Other minerals of economic importance include coal, lead, zinc, limestone, shale, clay, sand, and gravel. The most important coal beds are in Crawford and Cherokee Counties. Lead and zinc mines are in Cherokee County.

Raw materials useful for construction projects include limestone, alluvial gravel deposits in streams, and chert gravel found on the uplands. Large amounts of crushed limestone have been produced for concrete aggregate. Several thousand miles of roads have been surfaced with crushed limestone and chert gravel.

Structural building stone is quarried throughout the basin. The two limestones most widely used for buildings are the Ft. Riley and the Cottonwood.

Limestone beds with a high calcium carbonate content are used to produce agricultural limestone.

Land Use and Management

The Neosho Unit is divided into five major land resource areas in three separate land resource regions. Area 74, the Central Kansas Sandstone Hills; area 75, the Central Loess Plains; and area 76, the Bluestem Hills are all in the Central Great Plains Winter Wheat and Range Region. Area 112, the Cherokee Prairies is in the Central Feed Grains and Livestock Region. Area 116, the Ozark Highland, lies in the East and Central General Farming and Forest Region. (Exhibit 5)

Land use for each land resource area in the Neosho Unit is as follows:

Land Resource Area	Cropland		Rangeland		Forest		Other		Total Acres
	Acres	%	Acres	%	Acres	%	Acres	%	
074	18,982	42	24,872	55	--	-	1,483	3	45,337
075	365,923	66	134,076	24	649	<1	52,988	10	553,636
076	242,714	23	731,154	68	35,966	4	58,305	5	1,068,139
112	1,168,377	50	715,464	31	206,315	8	251,310	11	2,341,466
116	1,198	4	4,991	15	14,570	44	12,103	37	32,862
Total	1,797,194	45	1,610,557	40	257,500	6	376,189	9	4,041,440

Land use for the unit by land capability class is shown in the following table:

Land Capability Class	Acres by Land Use				Total
	Cropland	Rangeland	Forest	Other	
I	123,254	15,756	47,633	16,795	203,438
II	652,651	235,662	62,573	122,658	1,073,544
III	746,618	531,405	31,017	120,721	1,429,761
IV	227,771	172,528	6,986	30,588	437,873
V	0	0	0	0	0
VI	37,777	610,098	55,226	40,249	743,350
VII	9,123	45,108	54,065	23,372	131,668
VIII	0	0	0	21,806	21,806
Total	1,797,194	1,610,557	257,500	376,189	4,041,440

Only 1 percent of the unit lies in land resource area 74. Nearly all this land is in farms and ranches. Forty-two percent of the area is cropland. Winter wheat is the principal crop; grain sorghum, alfalfa, and corn are other important crops.

Rangeland occupies 55 percent of land resource area 74 within the unit. On the hardland areas, shortgrasses such as buffalograss and blue grama are predominant species. Side-oats grama, blue grama, and little bluestem are the predominant grasses found in the breaks areas. Tall and midgrasses occupy the sandy range sites. Sand and little bluestem, sand love-grass, and switchgrass are also common to these areas.

Cities and towns, roads, highways, railroads, water areas, and other non-agricultural land uses account for 3 percent of land resource area 74.

Land capability classes I, II, III, and VI occur in land resource area 74. Eighty-nine percent of the area is classified as I, II, or III. Only 47 percent of this is utilized for crop production.

The northwest portion of the unit lies in land resource area 75, the Central Loess Plains. Fourteen percent of the unit is accounted for in this land resource area. Land use consists of 66 percent cropland, 24 percent rangeland, 10 percent other, and less than one percent forest. Wheat, grain sorghum, and alfalfa are the major crops.

Grasses mentioned for land resource area 74 would predominate in land resource area 75 also.

Cities and towns, roads, railroads, water areas, etc. make up the ten percent of land cataloged as other in land resource area 75.

Land capability classes I through VI, excluding class V, can be found in the Central Loess Plains area of the unit. Fifty percent of the area is classified as land capability class III and 68 percent of this area is cropland. Class VI accounts for only 8 percent of the area.

MOST OF MARION COUNTY IS IN THE CENTRAL LOESS PLAINS. TWO-THIRDS OF THE LAND IN THIS LAND RESOURCE AREA, WITHIN THE NEOSHO UNIT, IS CROPLAND.

Land resource area 76, the Bluestem Hills, accounts for 26 percent of the Neosho Unit. Land use is divided into 23 percent cropland, 68 percent rangeland, 4 percent forest, and 5 percent other. Wheat, grain sorghum, soybeans, and other hay are the major crops.

The rangeland of land resource area 76 occupies the area commonly called the Kansas Flint Hills. Vegetation in this area is composed primarily of big and little bluestem.

Land uses not directly associated with agriculture make up the 5 percent other in land resource area 76.

Land capability classes I through VII, excluding class V, are found in area 76. Class VI accounts for 44 percent and 95 percent of this is rangeland. Land capability classes I, II, III, and IV account for 54 percent and class VII for 2 percent of the area.

The major portion of the Neosho Unit lies in land resource area 112, the Cherokee Prairies. Fifty-eight percent of the unit is in this area. Cropland makes up 50 percent of the total area. Wheat, grain sorghum, corn,

soybeans, and alfalfa are the major crops. Less than 1 percent of the cropland is irrigated. Most of the irrigated acreage is in corn and grain sorghum.

Rangeland occupies 31 percent of land resource area 112 in this unit. Native grasses found in land resource areas 75 and 76 are the major species found in this area.

The remaining land in land resource area 112 is cataloged as 8 percent forest and 11 percent other.

The extreme southeast 32,862 acres are in land resource area 116, the Ozark Highland of the Central General Farming and Forest Region. Forest is the major land use, representing 44 percent of the area. Other uses account for 37 percent, while only 4 percent is utilized as cropland and 15 percent as rangeland. Corn, feed grains, and alfalfa are the principal crops. The native grasses found in areas 74, 75, and 112 are the predominant species found in this area.

Water Resources

Surface Water - Surface water records are maintained at 17 continuous record stream gaging stations within the unit. Eight of these are on the Neosho mainstem; five are mainstem Cottonwood gages; and four are on tributaries of these two streams. Information about streamflow characteristics of the unit is also provided by four continuous record gages outside but close to the unit. Records date back as far as 1895 but are not continuous. Seven gages were established prior to the 1930's and nine in the late 1950's or early 1960's. Seven partial record stations were recently installed to supplement the continuous record system.

Mean annual runoff varies considerably from upper reaches of the Cottonwood to lower reaches of the Neosho. (Exhibit 6) The variation is more pronounced than annual precipitation would indicate. For example, annual precipitation over a small watershed in Marion County averages about 30 inches and average annual runoff is about 2.5 inches. By contrast, the same size watershed in Cherokee County may average 11 inches of runoff annually while average annual precipitation is 42 inches. Proportion of precipitation entering the stream as runoff increases from less than 10 percent in the northwest to more than 25 percent in the southeast.

Water resource planners must have knowledge of variability of flow in order to predict the usable supply of a stream. Recorded data indicates the actual range of flows and can be analyzed to determine probable frequency of occurrence and duration of flows of various magnitudes. All streams of the unit have had periods of no flow except Spring River and Shoal Creek. By contrast, the maximum daily discharge of record is 306,000 cfs in 1951 on the Neosho near Parsons. These extremes attest to the wide fluctuations of daily discharge that may be expected. Annual runoff variation is evidenced by records for the Cedar Creek gage where annual runoff in 1951 was 220 times that of 1956. Recorded daily and annual extremes make it clear that average values of stream flow and precipitation are merely reference points.

Rarely does a year go by without overbank flow on some stream in this unit. Many small watersheds of the unit average flooding several times per year. Floods have occurred in practically all months of the year but most frequently in May, June, and July. Hydrologic studies show that the 100 year frequency flood event probably has not occurred during the stream gaging period on several of the tributary streams. Maximum recorded flood peaks and a comparison with probable 100 year flood peaks are shown in Exhibit 7.

Chemical data is currently being collected at seven gaging stations within the unit as part of a program initiated by the State Board of Health in 1956. Three of these gaging stations are on the Neosho, one on the Cottonwood, one on Cedar Creek, and one on Spring River. Sediment data is not being collected at any of these stations.

Chloride, sulfate, and total solids concentrations generally are considerably less than the desirable upper limits set for public and most industrial water uses. However, water quality problems do exist in localized areas of this unit. (Exhibit 6) Numerous sulfate springs in Marion and Chase Counties contribute substantial sulfate to headwaters of the Cottonwood River. These sulfates affect quality of water stored in Marion Reservoir. Some tributary streams in areas of extensive coal mining are highly acid. Animal wastes have caused substantial deterioration of water quality for many stream miles below contributing feedlots.

Periodic measurements of suspended sediment have been made at several locations in the unit. Measurements have not been frequent enough to establish annual suspended sediment loads or maximum concentrations. Streams of the unit have suspended sediment loads consisting almost entirely of clay and silt. Bed loads are sands and coarser materials.

Groundwater - The Neosho River valley and its major tributary valleys produce moderate amounts of water from sands and gravels in the floodplain. Wells yield fair to good quality water from shallow depths. Water is furnished to municipalities along the river and to a limited extent to industry.

Most of the upland areas yield very little groundwater. Many test wells are dry or if drilled too deep the water may be of poor quality and unfit for domestic use.

A more favorable upland area for groundwater is the east and southeast part of Coffey County and a part of northeast Woodson County. Bedrock aquifers, chiefly sandstone, yield water at the rate of one to twenty gallons per minute. Another favorable area is at the headwaters of the unit in Marion, Chase, and Morris Counties. Wells penetrating the stratified Barneston and Wreford limestones generally have yields of 5 to 10 gallons per minute. Some wells may have yields as high as 50 gallons per minute.

Fish and Wildlife Resources

The Neosho Unit has an abundance of fishing water. (Exhibits 8 and 9) Two major streams, the Neosho and Cottonwood Rivers, have approximately 455 stream miles. They are noted for their catfish production. The Spring River in extreme eastern Cherokee County receives moderate to heavy fishing.

An inventory used for the State Outdoor Recreation Plan of 1968 shows a total of 21,710 surface acres of water in the unit. There were approximately 14,660 farm ponds in the 14 counties of the unit in 1967. This is an average of one farm pond for each 320 acres of the Neosho Unit. Allen County has the greatest number of farm ponds with an average of one pond per 123 acres.

The wildlife of the Neosho Unit is influenced by the subhumid climate of the northwestern half and the humid climate of the southeastern half of the unit. Whitetail deer and fox squirrel utilize the timber along the Neosho River and its tributaries. (Exhibit 10) The Flint Hills area in the northwestern half of the unit contains suitable habitat for antelope. Chase County has a small flock of Rio-Grande turkey which were released in 1968. Biologists estimate that wooded areas in Morris, Marion, and Chase Counties of the Neosho Unit could support 200 to 500 Rio-Grande turkey.

Whitetail deer, bobwhite quail, dove, greater prairie chicken, cottontail rabbit, fox squirrel, and waterfowl are game animals found in the unit. Whitetail is the only species of deer found in the Neosho Unit and is the only big game animal harvested. A small population of gray squirrels is present in the extreme southeastern corner of the unit.

The bobwhite quail is the most popular game species in Kansas in terms of hunter interest and participation. The Neosho Unit has the most dense populations of quail found in the Arkansas River Basin.

The areas of open pasture mixed with some farm crops provide habitat for the greater prairie chicken. The existence of this species is an important asset in the Neosho Unit. The unit's population is approximately 50,000 birds (spring population). Kansas is one of the few remaining states containing sufficient numbers of greater prairie chicken to warrant hunting seasons. The greater prairie chicken is classified as a rare wildlife species in the United States.

Populations of the other small game species (dove, cottontail rabbit, squirrel, and waterfowl) are present in the Neosho Unit. They are very important to local hunters. Other species which are not hunted are important parts of the ecological system.

The Neosho Unit is located within the Central Flyway and numerous species of waterfowl pass through the area during spring and fall migration. The major areas hosting

waterfowl populations in this unit are John Redmond, Council Grove, and Marion Reservoirs and the Neosho Waterfowl Management Area. (Exhibit 8)

The more predominant furbearers of this area include mink, muskrat, beaver, raccoon, opossum, skunk, and coyote. Populations of red and gray fox are also present.

WILDLIFE IS ABUNDANT IN THE NEOSHO UNIT. THIS IS A DEN TREE IN CRAWFORD COUNTY.

Forest Resources

The woodlands of the unit cover about 257,500 acres or 6.4 percent of the land area. Approximately five percent of the land area (207,400 acres) is in commercial forests, land suitable and available for continuous crops of saw logs, or other industrial forest products. (Exhibit 11) The woodlands are largely confined to the alluvial valleys and hillsides but spread over some of the uplands. These woodlands are mainly lowland plains hardwoods running primarily to elm-ash-cottonwood, elm-ash-walnut, and oak-hickory types. About 99 percent of the commercial woodlands are on privately owned farms. The balance is in state ownership.

Timber stands appear to be well-stocked but contain a great many cull and low value trees. Almost seven acres out of every ten need treatment to increase the number of desirable trees. In the past much of the woodland area was badly

cut, burned, and grazed. With reduced cutting, particularly of fuelwood, more fire protection and less grazing, it is improving. Mortality due to severe drought in the 1930's seriously reduced timber volumes. By 1964, sawtimber volumes totaled 307,720,000 board feet. In addition, there are 119,135,000 cubic feet of growing stock and short log trees. (Exhibit 14) Hardwoods comprise all of the sawtimber inventory.

Moisture has been a critical factor in determining the occurrence of native forests in the unit. The soils are mostly fertile and the growing season long, but forest cover is dependent on available soil moisture during dry periods.

Early settlement began in wooded areas, and the forests were indispensable, providing wood for construction of houses, fences, railroads, and fuel. The woodlands were cleared for agriculture or were reduced by grazing of domestic animals until they now cover about 1/3 of their original area.

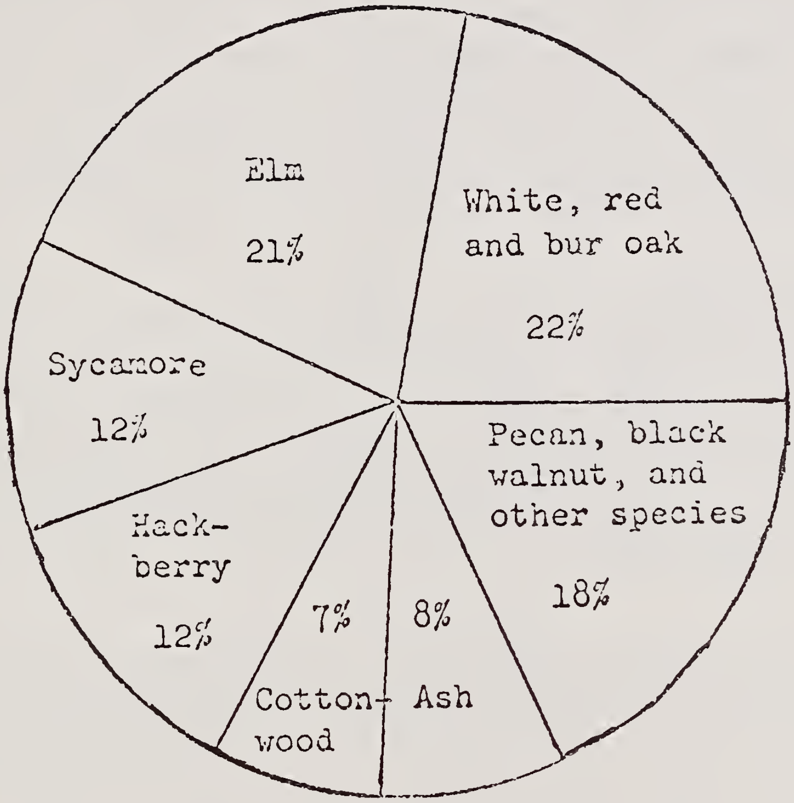
The net increase in commercial forest area over the last 30 years has been small. Land clearing or removal of trees for farm crops and other uses (such as pasture, urban, rights-of-way, flood control, and recreation) reduce the commercial forest area. Some tree planting is done each year, however, most of the increase in commercial forest area apparently came from natural restocking of trees in pastures and other nonforest lands.

The commercial forest land acreage is expected to remain about the same as in 1964 for the next 30 years. Factors such as reservoir and recreation development, urban expansion, highway construction, and the increasing demand for agricultural production will encourage timber clearing. These factors will be offset to some extent by planting and the invasion by trees of upland open areas, particularly pasture lands.

Noncommercial forest land, incapable of yielding commercial quantities of wood because of adverse site conditions, cover 50,100 acres. (Exhibit 12) These areas are primarily on the poor upland sites characterized by shallow, rocky soil. Much of the unproductive forest land is covered with blackjack oak, post oak, and elm. Other species commonly

found on unproductive forest sites throughout the unit include chinkipin oak, bur oak, honey locust, and cedar.

Sawtimber species composition is depicted by the following chart. The average sawtimber volume per acre is 2,524 board feet. (Exhibit 13)



Proportions of sawtimber volumes on commercial forest land by species and species groups, Neosho Unit, 1964

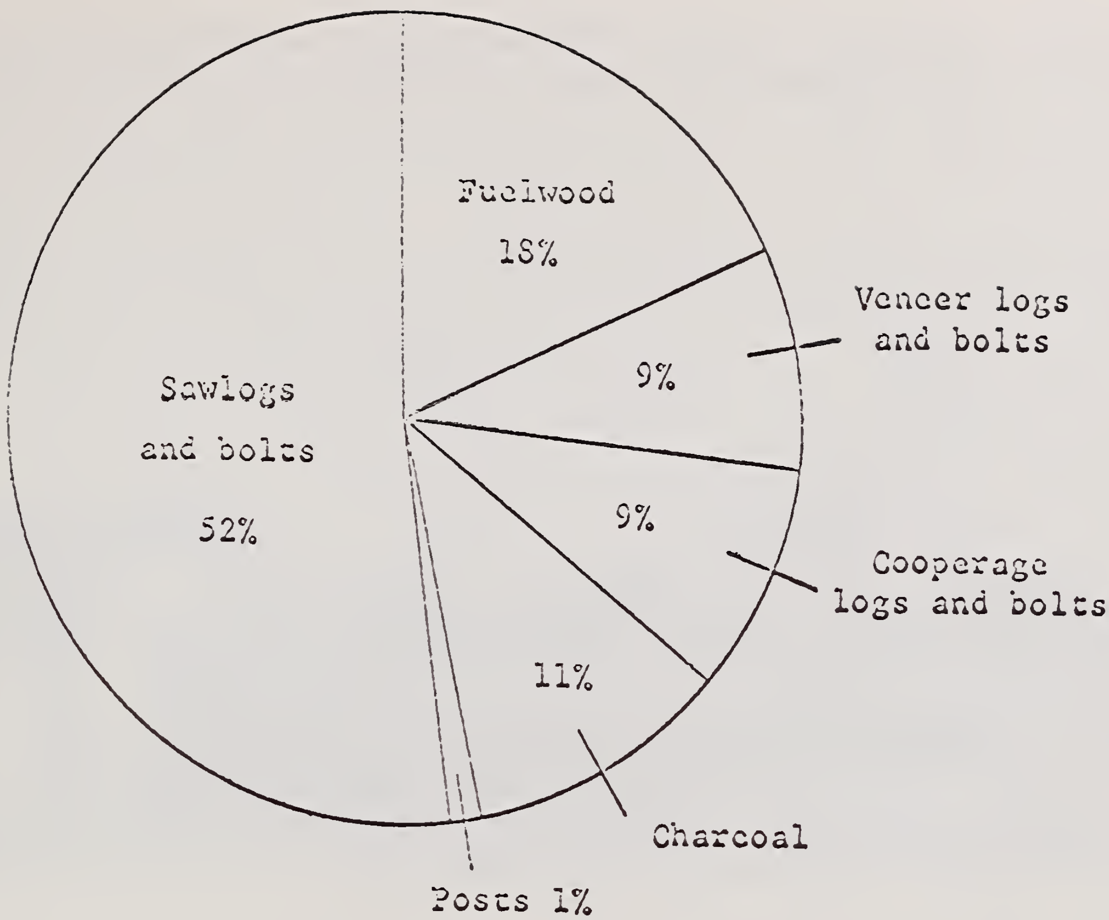
An unusually high proportion of the timber volume in this unit is found in large trees. Insufficient market and light cutting over a long period of time tended to accumulate timber of large diameter classes. Quality of logs is important where the timber cut is used for saw logs, veneer, and other products requiring large, straight and fairly clear logs. High-grade logs are more in demand because they yield higher value products and can generate better returns.

Black walnut is a very important species because of its high value, demand, and relatively good supply. Competition

for walnut has been very keen with many walnut buyers involved in the unit. Kansas is one of only a few states known to have a relatively large supply of good quality black walnut stumpage. The natural range of the black walnut extends over the entire unit. The species grows best on rich, well-drained soils. The trees are usually scattered in small numbers in hardwood stands or in narrow strips along streams or fence rows. Black walnut seldom grows in pure stands although growth in plantations has been found feasible. The total volume of black walnut amounts to over 15 million board feet on commercial forest land. A considerable volume is also found in wooded strips and in widely scattered pastures and fields.

Timber growth is good. Net growth per acre in 1964 averaged 20.5 cubic feet for growing stock on commercial forest land. The net annual growth of sawtimber in the unit in 1964 was approximately 8 million board feet or about 71 board feet per acre. (Exhibit 43) Hackberry sawtimber growth is the greatest, followed closely by cottonwood, elm, and ash.

In 1964 the total annual growth of hardwood forests exceeded the year's cut by approximately 160 percent with the possible exception of black walnut. Approximately 8 1/4 million board feet of hardwood timber was cut from commercial forest land in 1964. The value of this timber in the form of standing trees is about $15 per thousand board feet for most species. Oak stumpage averaged about $40 per thousand board feet. Black walnut stumpage price is much higher and varies from $250 to as high as $2,000 per thousand board feet for prime logs depending upon diameter, length, and defects. Use of the timber output is shown by the following chart:



Proportion of timber output, by products, commercial forest lands, Neosho Unit, 1964

In recent years, the cut of sawlogs and bolts, fuelwood, and charcoal has made up the greater part of the timber products. Almost all of these products were cut from roundwood. Very little came from plant by-products. Very little logging residue material is utilized. The cut for fuelwood and fence posts has been declining since 1935 and this trend is expected to continue. Approximately 5 million board feet of sawtimber was cut from commercial forest land in the unit in 1964. (Exhibit 43) The volume of sawtimber cut amounted to 1.6 percent of the sawtimber inventory.

Twenty-one wood-using plants were operating within the unit in 1964. (Exhibit 46) The output of lumber has decreased since 1935. The number of small sawmills has likewise decreased. There is only one mill that produces more than 1 million board feet of lumber annually. Much of the timber-based activity is located in rural communities which lack other industrial enterprise. In some areas

sawmills, cooperage mills, and charcoal plants are the main sources of employment for local residents.

THIS SAWMILL AT BURLINGTON, COFFEY COUNTY, HANDLES MANY TREE SPECIES FROM THE NEOSHO VALLEY.

Photo by: U.S. Forest Service

Employment in timber-based industries has dropped since 1935. In 1964, there were 280 people employed in the wood-based industries. (Exhibit 42)

Quality of the Natural Environment

A wide variation in environmental characteristics and quality exist in this unit. No area of the basin is more scenic than the Flint Hills area which covers the Cottonwood and upper Neosho portion. Picture this setting - rugged hills covered with lush green grass and lined with white limestone rimrock; herds of cattle scattered across the pastures; wide valleys with colorful crops of alfalfa, milo, and wheat; a meandering, tree-lined stream with clean water running in a thin stream between deep clear pools in the rocky bed. This mental picture may be identified as any one of several Flint Hills watersheds.

Further to the southeast the scene changes. The land use pattern is that associated with dairy and cash grain enterprise. Farm units are small and farmsteads are numerous. Annual rainfall is the highest in the state, over 40 inches, and vegetation abounds. Forests cover many of the steeper hillsides as well as the valley floors close to the streams.

These are two examples of the variation in environmental characteristics to be found in this unit. Both areas generally provide a high quality environment. Winters are mild with only a few days of snow cover normally. Summer temperatures are generally not excessive but high humidity does produce discomfort should the usual breeze die down.

Cattle feedlots and coal mining operations in this unit are examples of efficiency in production but both have histories of neglect of environmental quality. Feedlot odors and runoff pollute the air and water. Water pollution from this source has reached serious proportions on several streams. Definite steps are being taken toward control of feedlot pollution. Strip mining operations (primarily for coal) are doing a great deal of injury to land and water resources. In strip mining for coal the top soil and lower layers (mostly shale) have been removed from about 34,000 acres (1970) to as deep as 50 feet. The fertile top soil is taken off first; then the other material is dumped over the soil. There is no pretense at replacing the top soil layers in their original position, nor even at leveling. The one objective and effort is to get the upper layers - which, to the coal operator, are considered waste material - out of the way and remove coal. The landscape is left in an irregular series of ridges and trenches which mar the landscape. Most of the trenches are filled with water. The land cannot again be restored to crop production, but it is potential pasture and forest land. Remedial land treatment is economically feasible.

Man is well on the way to finding the balance that will provide his needs and protect his environment. Here again he has the basic ingredient necessary to accomplish this goal. He has a strong desire to protect and preserve rural America.

COAL STRIP MINING IS ENCROACHING UPON THIS CHEROKEE COUNTY FARM FROM TWO SIDES.

NEOSHO UNIT

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

Watershed Protection and Management

Erosion and Sediment Damage - Sheet erosion is the most damaging type of erosion affecting the basin. Channel or gully erosion may be considered minor. Widespread sheet erosion may range from slight to severe depending on conservation treatment, farming practices, and maintenance.

Most of the severe erosion generally occurs on steeply sloping cropland with shallow to moderately deep soil. Here the removal of the topsoil exposes less productive subsoil.

Erosion has permanently reduced the productive capacity of large upland areas. This is shown most remarkably on cropland best suited for grass.

Pasture in poor to fair condition is losing soil by sheet and gully erosion at an accelerated rate. Production is greatly reduced on voided and severely depreciated land.

Lowering of the erosion rate to acceptable levels may be accomplished by the application of land treatment measures and proper management. Gullies may be controlled by vegetation in most cases without large grade stabilization structures.

Channel erosion is minor or controlled by resistant bedrock in the channel. Stream bank erosion is locally severe. Each erosion area may require separate treatment.

Land stabilization problems in the unit are generally such that they may be solved through individual on-farm action. The project approach to grade stabilization is not needed.

Tributary floodplain scour may be quite severe. The damaged areas may have a crop yield reduction of 15-30 percent from normal over 10-15 percent of the floodplain. The large floodplains in the lower basin receive less severe scour damage, seldom exceeding 15 percent on 10 percent or less of the floodplain.

Sediments are deposited in roadside ditches, ponds, and reservoirs and may cause damage when deposited on floodplain soil. Silt and clay deposition causes little soil damage while infertile sand deposits may reduce crop yields 10-15 percent.

The sediment yield from an area with typical land use is approximately 0.70 acre feet per square mile annually. (Exhibit 16) The average yield from good pastureland is less than 0.35 acre feet per square mile per year. Ponds and reservoirs trap 70-95 percent of the sediment. This tends to greatly shorten the useful life of the reservoirs.

Land Treatment Needs - Conservation treatment currently is adequate on 56 percent of the 18,982 acres of cropland in land resource area 74. (Exhibit 17) Terracing to conserve moisture and reduce erosion is the principal land treatment practice needed.

Treatment is adequate on 89 percent of the rangeland in land resource area 74. Proper grazing use is the only practice needed.

The land treatment problems have been adequately solved on 20 percent of the cropland in land resource area 75. Terracing is the most needed land treatment practice. Sixty-nine percent of the cropland needs terracing. Residue management, mainly minimum tillage, is needed on 28,908 acres. Contour farming is needed on 8 percent of the area and permanent cover should be established on 3,659 acres.

Thirty-nine percent of the rangeland in land resource area 75 has been adequately treated. Proper grazing use is needed on 52,245 of the 134,076 acres. Brush control is needed on 18,171 acres. Five percent of the rangeland needs improvement for more efficient and uniform grazing through deferred grazing. Range seeding is needed on 3 percent of the rangeland. This will increase forage production, prevent excessive soil and water losses, and improve the natural beauty of the grazing lands.

Land treatment measures have adequately solved the conservation problems on 48 percent of the cropland within land resource area 76. The application of terracing and residue management will provide adequate treatment for nearly one-

half of the area. Permanent cover should be established on 3,155 acres presently being cropped. Contour farming is needed on 1 percent of the cropland area and drainage on 2 percent.

Over half of all the rangeland in land resource area 76 is adequately treated. To be adequately treated, proper grazing use needs to be practiced on 34 percent of the rangeland. Brush control is needed on 4 percent and range seeding on 4 percent of the rangeland.

The conservation problems have been adequately solved on 32 percent of the cropland in land resource area 112. Terracing and residue management are the principal land treatment needs. Seven percent of the area requires contour farming and 4 percent needs drainage. Permanent cover should be established on 14,021 acres. Planned irrigation systems are needed on irrigated land to efficiently convey and distribute water without excessive erosion or water losses. Irrigation water management is needed for more beneficial use of water.

More than one-third of the rangeland in area 112 has been adequately treated. Proper grazing use is needed on 19 percent of the rangeland, deferred grazing on 7 percent, and brush control on 12 percent. Range seeding is needed on 180,120 acres and brush control is needed on 70,250 of these acres.

Land resource area 116 has a total of 1,198 acres of cropland, all of which needs terracing. Sixty percent of 4,991 acres of rangeland has been adequately treated. Brush control is needed on 36 percent of the range and range seeding on 4 percent.

The general discussion beginning on page 190 also applies to the reasons that proper grazing use, residue management, and brush control are needed in this unit.

Woodlands - The woodlands of the unit were badly depleted during past development. Investigations show that "high-grading"-- consistently cutting only the best trees--has been a common practice. Many of the cut-over areas are characterized by a high percentage of poor quality and low value trees. Such stands give little economic

return. Many bottomland sites and some of the better upland sites have a good potential in terms of growth rates for commercial species such as walnut, hackberry, bur oak, and soft maple. Some of the areas are adequately stocked with desirable young trees but good management is needed to produce high-quality commercial timber. This will require limited grazing; removing dead, cull and weed trees; thinning dense thickets; and pruning desirable crop trees. Additional work is needed to (1) develop markets and attract industry, (2) obtain a balanced distribution of age classes, and (3) establish and maintain growing stock that will improve species composition.

Insects and disease cause losses in timber production through a reduction in growth, lower quality, deformities, and death. Such losses are greater than the annual harvest. More research into the control of forest insects is needed.

Grazing of woodlands is widespread. Grazed woodlands generally rate only poor to fair in hydrologic condition, while ungrazed areas usually rate good to very good. Continued heavy grazing will eventually result in the elimination of much of the woodland cover. However, more and more farmers are using improved pastures and hay meadows as a source of forage and are keeping the livestock out of their woodlands. In some cases grazing of woodlands could possibly be the best use. If so, the tree cover should be removed to improve forage production. If, on the other hand a protected forest is shown to be the best use, protection and intensive management of the woodlands should be practiced.

Strip mining for coal is responsible for loss of some timber stands.

The general discussion beginning on page 192 also applies to the watershed protection and management needs of woodlands in this unit. These needs are quantified on page 276.

Strip Mined Land - Approximately 39,500 acres (1970) of land have been disturbed by strip mines. Some 34,000 acres of this land are involved in coal mining operations. The potential exists for strip mining on an estimated additional 596,000 acres (all of the agricultural land in Bourbon, Cherokee, and Crawford Counties). Redevelopment of all lands strip mined for coal, following a multiple-use concept establishing grassland and fish and wildlife habitat, is needed. Tree and shrub cover should be incorporated in grasslands, through direct planting and retention of existing well-forested areas, for stabilization of erosion hazard areas.

Floodwater and Sediment Damages

Flood damages on mainstem floodplains of the Neosho, Cottonwood, and Spring Rivers were not evaluated for this

report. Exceptions occur where damages were identifiable in the immediate vicinity of a tributary outlet. Floodplain acreages and damages presented are those occurring on tributary streams. (Exhibit 18a)

The Neosho Unit has the highest average precipitation and surface runoff of any area of the basin. Stream channel capacities are not significantly larger than those of other areas, in fact some streams have relatively small channel capacities. A high proportion of upland is in crops. These factors combine to produce frequent and severe flooding. Overflow occurs along some tributaries as many as three or four times per year. A major flood can be expected somewhere in the unit nearly every year.

Floodplain soils are fertile and extensively cultivated, therefore, flooding means large dollar losses to the agricultural industry. In addition to crop damage, other agricultural damages are high. Washed out fences, flooding of stored grain and hay, and debris scattered across fields are examples of other agricultural damage. Roads, bridges, and railroads are also damaged by flooding.

Several cities and small towns are located at least partially on floodplains of tributary streams. Floods have been disastrous to some of these towns. A few have been abandoned because of recurrent flood problems. Cities that are damaged by overflow of tributary streams include Council Grove, Iola, and Dunlap.

Agricultural areas suffer the greatest flood damage. An estimated 292,537 acres along tributary streams are subject to inundation by a 100-year frequency flood (a flood which has a one percent chance of occurring in any given year). Some 221,129 acres of cropland, 33,700 acres of pasture, and 37,708 acres of miscellaneous use (including channel and adjoining timber) would be inundated by this size flood. (Exhibit 18)

Average annual crop damages based on 1980 projections are estimated to be $3,814,900. Other agricultural flood damages, including damage to stored grain and hay, fences, farm buildings, and farm machinery, average $272,600 annually. Floodplain scour and sediment damages are estimated to average $219,100 annually on about 22,363 acres. Total average annual agricultural damage is estimated to be $4,306,600.

FLOODWATERS WASHED GRAVEL FROM A ROAD INTO A CROP FIELD IN ALLEN COUNTY.

Non-agricultural floodwater damage includes damage to roads, bridges, railroads, oil fields, and urban areas. Road and bridge damage is the major item in this category averaging $574,500 annually. Road and bridge damages occurring at crossings of upland draws and gullies were not evaluated but probably total more than that occurring along floodplains. Railroad damage is relatively minor. Average annual damages are estimated to be $32,200 on sixty-eight miles. Other types of damage such as oil field damage is also minor averaging $9,400 annually. Urban floodwater damage averaging $5,600 annually was evaluated in the following towns: Council Grove, Dunlap, and Iola. The Crawford County Fair Grounds and Parsons Golf Course are also subject to flood damage. Urban flood damages are primarily interruption of business, cleanup of sediment and debris, and loss in valuation of property. Total average annual non-agricultural flood damage is estimated to be $621,700. (Exhibit 18)

Indirect damage is estimated to average $522,400 annually. Indirect losses include interruption of transportation and utilities and loss of business to those serving agricultural communities.

Total tributary floodplain damages, including agricultural, non-agricultural, and indirect losses are estimated to average $5,450,700 annually.

Agricultural Water Management

Drainage - Runoff removal is very slow in areas of nearly level, deep, dark, clayey soils such as the Osage series. Drainage outlets are often absent in these areas, compounding the problem of low permeability. An early estimate placed the total area of drainage needs at about 180,000 acres. The 1959 Conservation Needs Inventory shows drainage works accomplished on 54,700 acres leaving about 125,000 acres of problem area. The 1967 Conservation Needs Inventory places the remaining cropland problem area size at 46,431 acres.

These figures show substantial progress toward solution of the cropland drainage problem. Progess has been accomplished primarily through individual on-farm action rather than through group or project action.

Irrigation Demand - Irrigation is not and probably will not be a large water user in this unit. (Exhibits 26 and 31) This is due to high rainfall which normally ranges from 30 to 42 inches across the unit, low evapotranspiration rates, lack of adequate groundwater supplies or reliable surface water supplies, and little land suitable for irrigation. (Exhibits 6, 21, and 22) There is still a need for irrigation to stabilize farm income. (Exhibit 45) A small portion of the extreme southeastern part of the unit has sufficient groundwater in combination with land suitable for irrigation. (Exhibit 20) The groundwater is from the Roubidoux formation, a consolidated aquifer which ranges from 400 to 1,500 feet below the ground surface. Some of the water from this aquifer is highly mineralized. Because of the depth and quality problems it is not expected that this aquifer will be extensively tapped for irrigation purposes. Most of the irrigation in this unit will depend on surface water supplies. There are adequate surface water flows (Exhibit 6) and suitable reservoir sites in most areas which could provide sufficient storage for irrigation. However, a high level of management is required to irrigate profitably in this area. (Exhibit 47)

Most of the present irrigators are using water directly from streams. (Exhibit 21) They are having limited success because this source is unreliable without carry-over storage. There are stabilized flows downstream from Marion, Council Grove, and John Redmond Reservoirs but since there is no specific commitment for irrigation from this source, it cannot be depended upon for private irrigation during an extended low-flow period.

There are quality problems with groundwater particularly in the southern counties of the unit. (Exhibit 22) Surface water quality generally is satisfactory. (Exhibit 6)

Drainage problems will limit irrigation in some areas because of clay and claypan soils.

Rural Domestic and Livestock Water - The projected rural domestic water demands increase slightly while the livestock water demands increase over four times over the 50-year study period. (Exhibits 26 and 31) The rural population density of the unit ranges from 2 to 15 persons per square mile and is not expected to change much in the future. (Exhibit 27) Commercial feedlot development is expanding rapidly in the unit, particularly in Lyon, Chase, Morris, and Marion Counties. (Exhibit 28)

The general discussion beginning on page 44 also applies to the character of livestock feeding operations in this unit.

The groundwater supplies are generally inadequate in this unit for rural domestic and livestock needs and the surface water supplies are not reliable during droughts. (Exhibits 6, 19, and 22) There are groundwater and surface water quality problems primarily in the southeast portion of the unit. (Exhibit 22) More rural water districts are needed to supply future rural domestic and livestock needs in this unit.

<u>Non-Agricultural Water Management</u>

Municipal and Industrial Water Needs - The municipal supplies are from groundwater in the western portions of the unit and primarily from surface water in the central portion. (Exhibit 27) Groundwater supplies in the central portion are generally inadequate. (Exhibit 22) There are

some quality problems with groundwater particularly in the southeastern portion of the unit. (Exhibit 22) Surface water will supply municipal and industrial needs when sufficient storage is provided. (Exhibit 6) More reservoir storage is needed to meet future municipal and industrial demands.

Industrial water demands are expected to increase steadily. (Exhibits 19 and 31) Most of the industrial water demand is for mining of oil and natural gas. There will be increased water demands for metallic mining, mostly sands and gravels, by the year 2020. It is anticipated that more and more of the industrial water demands will be met by municipalities and possibly by rural water districts.

Recreation - The recreation demands are based strictly on present and projected population in each county. Comparing available recreation areas with the demands within a single county may indicate a considerable deficit or surplus for that county. (Exhibit 29) However, adjoining counties may have a surplus or deficit which balances out over a multi-county area. For example, Chase County shows a deficit for boating water at the present time, while adjoining Morris County shows a surplus in boating water supply because of Council Grove Reservoir. (Exhibit 8)

There is a surplus of boating and fishing water in this unit because of the three existing major reservoirs - Council Grove, Marion, and John Redmond. (Exhibit 30) There are also a number of small reservoirs in the unit, making it one of the more desirable in the state from a water recreation standpoint. (Exhibit 8) Swimming and camping are the only activities which show a future need during the study period.

Fish and Wildlife - The general discussion beginning on page 47 also applies to the fish and wildlife problems and needs in this unit.

There is need for pollution control. Pollution does not limit fisheries over an entire stream system. Various forms of pollution (municipal, industrial, feedlot runoff and mining operations) exist locally and severely affect specific sections of the Neosho and Cottonwood Rivers.

Selective harvesting of fish causes changes in the dominant fish populations of existing lakes. A proper

balance of fish populations is a necessity for maximum production. Constant management and annual surveys are required to maintain good quality fishing.

Pollution

The general discussion beginning on page 48 also applies to pollution problems in this unit. Fifty percent of the mean annual flow will provide more than enough water for pollution abatement needs in this unit were it to be all developed. (Exhibits 19, 28, 31, and 32)

Range and Forest Fires

Following are the number of fires and acres burned by major cause for the five-year period 1963-1967 for protected state and private land in the Neosho Unit:

Item	Year					5-Yr.
	1963	1964	1965	1966	1967	Ave.
No. of lightning-caused fires	1	1	5	13	13	7
No. of man-caused fires	1	67	94	294	275	146
Area burned[1/] - acres	284	5,078	2,301	22,417	82,460	22,508

1/ Includes organized rural fire districts only

In spite of potentially disastrous burning conditions in 1967, only 82,460 acres of forest and grasslands in the unit were burned. Two large fires accounted for 60,000 acres: Marion County 20,000 acres March 1; and Chase County 40,000 acres March 10. The number of fires in 1967 was 19 fewer than in 1966 although 60,043 acres more were burned. The number of fires and total area burned would have been more except for the fact that more land was under protection than in earlier years.

A general discussion of the basin-wide range and forest fire problem is included in the Walnut-Verdigris Unit narrative beginning on page 199.

Relationship of Water Problems to Impairment of Natural Beauty

Occasionally short, severe droughts cause desiccation of the crops, grasses, and trees with a resultant browning of the otherwise lush green foliage. Stream flows become inadequate for water supplies and dilution of wastes.

More frequently in this unit the problem is one of too much water. Heavy rains, usually of short duration, produce flooding. Many streams average flooding as often as three times per year. Flood flows scour the land and deposit sediment on the land, in channels, and in reservoirs. After the water recedes the vegetation is unsightly and foul smelling. Wildlife habitat is degraded. The recreational use of flood control reservoirs is impaired for several weeks following a flood.

Water pollution is from many sources including: feedlot runoff; erosion of the land; municipal waste; runoff from mining and oil field operations; and other industrial waste discharges. All of these pollutants degrade the natural beauty of streams, especially in times of low streamflow.

NEOSHO UNIT

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Land Treatment

The general discussion beginning on page 53 also applies to programs for accomplishing land treatment in this unit.

In the Neosho Unit, the first soil conservation district was organized in Labette County in June 1938 and the last was in Greenwood County in January 1950. To date, 32 percent of the cropland acres and 48 percent of the rangeland acres have been adequately treated.

THIS DAM IN LABETTE COUNTY SERVES AS A ROADBED AND PROVIDES FLOOD CONTROL. THE RESERVOIR PROVIDES LIVESTOCK AND DOMESTIC WATER.

Photo by: Labette County Soil Conservation District

Upstream Watershed Projects

The general discussion beginning on page 53 also applies to watershed program provisions in this unit.

Nine applications for assistance under P.L. 566 have been received and approved.* (Exhibits 34 and 35) Nearly 17 percent (670,537 acres) of the unit area is covered by these nine applications. Status is as follows:

* Information given is based upon 8-1-70 project status. The tabulation on page 14a updates to 12-31-74 status. Exhibits 34 and 38 have also been updated to 12-31-74 status.

Watershed	Status	Area Acres
Silver Creek	Completed	18,418
Big Creek (Coffey, Lyon, Greenwood, and Woodson Co.)	In Planning	84,100
Middle Creek	Awaiting Planning	72,838
Diamond Creek	" "	102,600
South Fork	" "	179,005
Peyton Creek	" "	21,800
Deer Creek	" "	71,900
Eagle Creek	" "	48,904
Big Creek (Neosho and Allen Counties)	Terminated	70,972
		670,537

Silver Creek is the only watershed authorized for construction in this unit. It has since been completed. Silver Creek works of improvement includes land treatment, 6 floodwater retarding structures, 2.0 miles of floodway, and 400 lineal feet of dike. Storage of the six floodwater retarding structures totals 303 acre feet for sediment reserve and 2,514 acre feet for floodwater.

THIS WATERSHED DAM IN SILVER CREEK WATERSHED, CHASE COUNTY, PROTECTS CROPLAND FROM FLOODING.

The Silver Creek project benefits 1,159 acres of agricultural land. Land treatment and structural measures are expected to produce benefits averaging $20,400 annually. Average annual damages will be reduced by 76 percent. Since completion in June 1966 the project has demonstrated its effectiveness several times. Severe flooding of neighboring streams was in marked contrast to the controlled flows of Silver Creek in 1969.

Resource Conservation and Development Projects

The general discussion beginning on page 148 also applies to the resource conservation and development program in this unit.

The application has been approved for planning of the nine county See-Kan Resource Conservation and Development project in southeast Kansas. A large part of the project area is included in this unit. Counties involved in the project are Cherokee, Labette, Montgomery, Wilson, Neosho, Crawford, Bourbon, Allen, and Woodson (see pages 13-14 for current RC&D status and basin area involved).

Flood Control Projects

Three Corps of Engineers reservoirs have been constructed within this unit, all under jurisdiction of the Tulsa District. (Exhibit 34)

(1) Council Grove Reservoir was completed in October 1964 at a cost of $11,609,000. Initial flood control storage is 76,000 acre feet. Initial conservation storage for water quality control, water supply, and sedimentation is 38,300 acre feet. Ultimate development is planned for 63,700 acre feet for flood control and 50,100 acre feet of conservation storage.

(2) Major construction of John Redmond Reservoir was completed in December 1965. The estimated cost of $29,264,000 includes $970,000 for a wildlife refuge and $294,000 for additional recreational facilities. Total storage capacity is 644,600 acre feet with 562,500 acre feet allocated to flood control in ultimate development. Other purposes are water supply and water quality control.

(3) Construction of the $13.6 million Marion Reservoir was completed in 1968. The reservoir has a total storage of

146,800 acre feet, of which 60,000 acre feet are available for floodwater storage. The normal pool contains 86,800 acre feet for water supply and conservation uses.

The Iola, Kansas, local protection project was completed in 1938. Repairs to the project were completed in 1966. The one mile long levee provides protection to a city park and related improvements. Levee cost was $23,790. Accumulated project benefits are $23,100.

Cedar Point Reservoir, Chase and Marion Counties, was authorized by the Flood Control Act of 1950. Storage capacity will be 108,600 acre feet. Estimated cost is $12 million. This project is now inactive.

Irrigation

Presently about 3,200 acres are being irrigated in this unit using an estimated 4,800 acre feet of water. Surface water is the primary source. By 1980 supplemental irrigation will probably be applied to 5,400 acres using 8,100 acre feet of water. (Exhibits 19, 20, 21, and 22)

Drainage

Three drainage districts have been organized in this unit, one each in Labette, Coffey, and Marion Counties. The Neosho Drainage District, Labette County, was organized in 1929. It is now inactive. The two active districts cover an area of 9,500 acres. Lakeview Drainage District, Coffey County, was organized in 1938. Cottonwood Valley Drainage District, Marion County, was organized in 1917.

Water Supplies for Rural Domestic and Livestock Uses

Rural water districts are proving to be a successful means of supplying rural water needs. They have the power to develop or contract for water supplies to satisfy the needs of an area. Financing is accomplished by loans available through Farmers Home Administration. As of June 1971, forty-two rural water districts had been organized in this unit. Information regarding these districts is as follows:

Name	Year Organized	Number of Families Served	Status 6-1-71
McPherson County No. 1	1964	56	Operating
Lyon County No. 1	1965	94	Under Construction
" " No. 2	1966	74	" "
" " No. 3	--	61	" "
" " No. 4	--	218	Operating
" " No. 5	--	175	Organized
Coffey County No. 1	1964	50	Operating
" " No. 2	--	336	Under Construction
Woodson County No. 1	1966	121	" "
Allen County No. 1	1957	7	Operating
" " No. 2	1959	13	"
" " No. 3	1959	20	"
" " No. 4	1959	7	"
" " No. 5	1960	6	"
" " No. 6	1960	16	"
" " No. 7	1960	37	"
" " No. 8	1960	47	"
Neosho County No. 2	1963	178	Operating
" " No. 3	1963	24	"
" " No. 4	1964	206	"
" " No. 6	1965	71	"
" " No. 7	--	89	Under Construction
Chicopee RWD	1951	108	Operating
Crawford County No. 1	1962	36	Operating
" " No. 2	1963	156	"
" " No. 3	--	60	"
" " No. 4	1964	256	"
" " No. 5	1965	158	"
" " No. 6	1967	202	Organized
" " No. 7	--	195	"
Cherokee County No. 1	1963	96	Operating
" " No. 2	1965	103	"
" " No. 3	1966	209	"
" " No. 4	1966	249	Under Construction
" " No. 5	1966	58	Operating
Labette County No. 1	1964	37	Operating
" " No. 2	1963	28	"
" " No. 4	1965	33	"
" " No. 5	1966	205	Under Construction
" " No. 6	1967	200	" "
" " No. 8	--	230	Organized
Marion County No. 1	--	150	"

The bulk of these rural water districts obtain water from cities. Only a few lakes are being used for self-supplied rural water districts at the present time.

Municipal and Industrial Water Use

Seventy percent of the municipal water is obtained from surface water sources. (Exhibit 27) Cities in the Cottonwood and Spring River subbasins rely mainly on groundwater sources. Those along the Neosho depend upon surface water. Virtually all water for industrial uses is taken from surface sources.

Six cities are served by municipal water supply reservoirs. They are Council Grove, Emporia, Gridley, Yates Center, Parsons, and Altamont. Industrial reservoirs are owned by two electric companies. Twenty-four channel or overflow dams furnish water for municipal and industrial purposes.

Provisions have been made for future municipal or industrial water supply from Council Grove, John Redmond, and Marion Reservoirs. To date users have not contracted for any of the water available from these reservoirs.

Recreation

The general discussion of the Land and Water Conservation Fund Act, beginning on page 56, also applies to this unit.

Recreation facilities are available and being used at John Redmond, Council Grove, and Marion Reservoirs. Other major reservoirs offering recreation opportunities within close proximity to this unit include Pamona, Fall River, Toronto, and Elk City.

Water-related recreation facilities also exist at three state lakes in Chase, Neosho, and Crawford Counties; the Neosho County Wildlife Refuge; Marion County Lake; four municipal overflow dams at Burlington, Cedar Point, Cottonwood Falls, and Neosho Falls; and 29 municipal and industrial lakes and overflow dams. The Crawford County State Lake is actually a series of deep, narrow pools resulting from strip mining operations. Several other strip mining areas have been converted to public fishing waters by the State Forestry, Fish and Game Commission in cooperation with the landowners.

MANY OF THE STRIP MINING PITS IN CRAWFORD COUNTY PROVIDE FISHING.

Thousands of farm ponds in the unit are available for private recreation. Permanent pools of floodwater retarding structures in Silver Creek Watershed also offer incidental recreation opportunities. Surface area of these pools totals 59 acres.

Fish and Wildlife

Forestry, Fish and Game Commission biologists conduct surveys and evaluate fish and wildlife within the unit on an annual basis. Fish stocking and rehabilitation programs are initiated when needed and when funds are available.

The Forestry, Fish and Game Commission has recently transplanted wild Rio Grande turkeys in the unit with limited success. (Exhibit 10)

The Forestry, Fish and Game Commission has designated eight public hunting areas containing approximately 26,000 acres in this unit. The 6,472 acre area around John Redmond Reservoir is the largest of these areas. (Exhibit 8) This area is administered by the Bureau of Sport Fisheries and Wildlife. Game management areas, leased from the Corps of

Engineers, are located at two other reservoirs in the unit (Council Grove and Marion). The Neosho Waterfowl Management Area is developed as a resting area for migrating waterfowl. The Commission has purchased several tracts of land, totaling 1,280 acres, adjacent to the proposed Big Hill Reservoir in Labette County and is presently managing this land as a game management area open to public hunting. Lyon County State Lake has approximately 550 acres open to public hunting. Approximately 6,100 acres of abandoned strip mined lands in Crawford and Cherokee Counties are held in fee title by the Forestry, Fish and Game Commission. The fisheries resource is being managed through water quality manipulation and habitat for wildlife is being developed around them.

Cooperative State-Federal Forestry Programs

The Walnut-Verdigris Unit includes discussion of cooperative state-federal forestry programs beginning on page 212.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Land Use and Conservation Treatment

Land treatment measures have been installed on 32 percent of the cropland area. Residue management and terracing are the major conservation needs. Permanent cover should be established on approximately 20,835 acres. Nearly one-half of the rangeland has received adequate conservation treatment. The principal measures needed to complete treatment of the rangeland are proper grazing use, range seeding, and brush control.

It is reasonable to project that about 66 percent of the cropland treatment needs and about 80 percent of the rangeland treatment needs can be accomplished by the year 2000. Projections assume continuation of current incentive programs and are based upon established trends.

Upstream Impoundment Sites

Topography of most of the unit is gently rolling with sites for floodwater retarding dams generally available. In the Flint Hills region of the Cottonwood subbasin, topography is rolling to rugged and sites are plentiful. By contrast, portions of the Spring River subbasin have limited relief and few sites are available. (Exhibit 36)

In this unit, few sites are available that are totally in pasture. It is usually desirable to locate sites close to primary damage areas for maximum damage reduction. This goal is attainable in most watersheds of the unit but not without inundation of cropland.

Over 1,000 physically possible floodwater retarding structure sites were examined in this unit. Only three percent of these sites were classified as having below average detention storage characteristics. Thirty-five percent fell in the average group. The remaining 62 percent were classified as above average or relatively inexpensive. The above average group would have wide, flat storage reservoirs where floodwater storage requirements could be met with relatively low dams. Conversely, below average sites require high, relatively expensive dams to store floodwaters.

Most of the above average sites from the standpoint of floodwater storage characteristics are found in gently rolling areas of the upper Cottonwood watersheds and in watersheds all along the Neosho River. Sites classified as average or below average were found mainly in rugged areas of the Flint Hills. These sites are still desirable in spite of relatively high cost because large drainage areas can be controlled with less cropland inundated by reservoirs.

Forty-four percent of the sites have drainage area sizes in the one to three square mile range. Thirty percent are in the three to six square mile group. Another 15 percent are in the six to twelve square mile range. Seven percent have between twelve and twenty square miles of drainage area. A small number of sites studied had less than one square mile or over 20 square miles of drainage area.

Total drainage area controlled by sites investigated is 1,529 square miles or 24.2 percent of the unit area. Some sites are in series. No sites were included on the main-stem Cottonwood, Neosho, or Spring Rivers or that exceed P.L. 566 maximum size limitations.

Channel Work

The potential for added flood protection by channel improvement is widely variable in this unit. Several streams have relatively small channels and will continue to flood frequently even after installation of floodwater retarding dams. In some of these cases further study may prove channel improvement to be both physically and economically feasible. No particular pattern of location of these instances was noted.

Agricultural Water Management

Storage - Irrigation storage in this unit is that required to meet supplemental water needs. More than 60 percent of sites studied have below average water supply storage characteristics. Gross yield to the sites is generally high but sites involving large shallow pools have greatly reduced net yield potential because of evaporation and seepage losses. Cost of net storage will be high. However, sites with average or above average water supply storage characteristics are available.

Good potential exists for rural domestic and livestock water storage. Nearly all watersheds have some potential water supply storage capability. Reservoir sties are available in all areas of need. Maximum economy can be attained if many users are tied to a single reservoir. Rural water districts have the power to implement such projects with loans available through Farmers Home Administration.

Groundwater recharge from surface storage is not feasible in this unit. Subsurface conditions limit the effective recharge of aquifers.

One hundred nine sites were found to have some degree of physical potential for multiple-purpose development including, if needed, agricultural water storage. Approximately one third of the sites were found to have average water storage characteristics. Only a few were above average. The majority are in gently rolling topography and are not considered most desirable from the standpoint of water surface exposed to evaporation losses. The most promising sites were found in the Flint Hills portion of the unit. (Exhibit 37)

Drainage - It is reasonable to assume that nearly all of the remaining drainage problems can be solved through individual on-farm action by the year 2000.

Non-Agricultural Water Management

Multiple-purpose sites are available to provide municipal-industrial water storage to most of the small cities in the unit. Sites with potential to efficiently supply larger cities are very limited and would most likely be available in the Flint Hills portion of the unit. Only about 40 sites were found in the entire unit that have average or above average municipal-industrial storage characteristics and most of these have small drainage areas. Yields are generally capable of replenishing carryover storage volumes needed for small city or industry use. (Exhibit 37)

Sites for development of multiple-purpose reservoirs including recreation or fish and wildlife storage are available in nearly every watershed of the unit. The most desirable sites are found in the Flint Hills portion. Yields are generally sufficient to replenish carryover storage volumes throughout the unit. Recreation sites are enhanced by scenic

surroundings. Fish and wildlife developments in the tree-lined valleys will offer favorable habitat for edge creatures.

Water Quality Control - The general discussion beginning on page 62 also applies to potential development of water supplies for water quality control in this unit.

Availability of Land and Water for Potential Development

The 109 reservoir sites considered to have potential for multiple-purpose development have a physical storage capability of 108,000 acre feet. Yield will not limit this potential. This volume is above the sediment and floodwater storage reserves that would be necessary for single purpose development. Water quality in impoundments will be adequate for most uses.

Cropland would be involved in development of the full storage potential of many sites. Nearly all of the land involved is in private ownership. The possibility of encroachment on roads, farmsteads, or pipelines increases as storage is increased in most sites. Railroads or highways would be involved in a very few cases. Towns would not be affected by any of the sites. Other larger sites not investigated are likely to involve more serious encroachment on physical improvements.

NEOSHO UNIT

OPPORTUNITIES FOR DEVELOPMENT WITH USDA PROGRAMS

Land Treatment Measures

The general discussion beginning on page 65 also applies to opportunities for development of land treatment in this unit with exception of the Great Plains Conservation Program.

The total cost of installing the needed land treatment measures listed in Exhibit 17 for the Neosho Unit is estimated at $24,000,000.

Upstream Watershed Projects

The general discussion beginning on page 66 also applies to opportunities for P.L. 566 development in this unit.

Early Action Projects - Twenty-one upstream watersheds within the Neosho Unit were found to be feasible and needed within the next 10-15 years. These are in addition to watershed projects that have reached planning status or beyond.

Watershed Name	CNI No.	Drainage Area Acres
Rock Creek	1t-2	82,545
Allen Creek	1t-5	79,705
Crooked Creek	1t-7	129,241
Cherry Creek	1t-10	36,677
Deer Creek	1t-13	75,190
Owl Creek	1t-15	96,632
Canville Creek	1t-18	54,026
Hickory Creek	1t-22	80,712
Lightning Creek	1t-23	161,420
Labette Creek	1t-24	152,779
Cherry Creek	1t-25	74,601
Fly Creek	1t-27	39,783
Diamond Creek	1t1-3	97,066
Middle Creek	1t1-4	73,568

Watershed Name	CNI No.	Drainage Area Acres
Peyton Creek	1t1-5	56,525
Buckeye Creek	1t1-6	25,346
Doyle Creek	1t1-7	193,615
Cedar Creek	1t1-8	150,173
Coal Creek	1t1-11	86,601
South Fork Cottonwood	1t1-12	179,530
Cow Creek	1t2-19	156,958
Total		2,082,693

These 21 watersheds include 2,082,693 acres or 52 percent of the Neosho Unit area. Added to the two projects already having attained or passed planning status under P.L. 83-566, the total is 23 watersheds covering 2,179,576 acres. (Exhibit 38)

It would be possible to economically control about 1,210 square miles or 19 percent of the area included in the 23 feasible watersheds. These figures are based upon an estimate of the physical, economic, and social aspects of each watershed. Local interests may have valid reasons for variation from systems for which data is summarized in this report would produce different physical and economic values.

The 1,210 square miles of control can be accomplished by installation of 192 reservoirs. It is estimated that 175 of these sites will be single purpose floodwater retarding structures and 17 will be multiple-purpose floodwater retarding, recreation, and water supply structures. Total storage capacity of the 192 structures will include: sediment, 82,622 acre feet; detention, 263,680 acre feet; and other 16,500 acre feet. Surface area totals are: sediment pools of single purpose floodwater retarding structures, 7,096 acres; permanent pools of multiple-purpose floodwater retarding and recreation structures, 3,108 acres; and detention pools (all structures), 32,794 acres. (Exhibit 39)

Long Range Projects - There are sixteen additional watersheds that merit future consideration for project development. At present these projects are not

economically feasible because of high interest rates, high costs, and evaluation procedures. These projects should be re-evaluated if any favorable changes occur in evaluation factors. This group of projects includes 2,670 square miles, 42 percent of which could be reservoired by 68 structures. Total storage capacity would probably include: sediment, 30,314 acre feet; detention, 104,068 acre feet; and recreation, 2,390 acre feet. Surface area totals are: sediment pools of floodwater retarding structures, 2,803 acres; permanent pools of multiple-purpose structures including recreation storage, 1,111 acres; detention pools (all structures), 13,421 acres.

Cooperative State-Federal Forestry Programs

Seedling trees are needed for reforestation and wind barriers. There is opportunity to bring approximately 76,000 acres into forestry production by tree planting. Species composition may be improved by planting and seeding. Most of the past planting has been done by private individuals, the State Forestry, Fish and Game Commission, and by local coal companies to rehabilitate strip-mined land. This type of land treatment will help develop a protective cover. Nearly all of the forestry land treatment measures can be accomplished by available USDA programs. The following table lists estimated land treatment measures proposed on state and private forest lands, Neosho Unit, to 1980 (estimated cost - $7,935,200):

Item	Unit	Amount
Timber surveys	Acres	207,000
Forest management (technical assistance) timber thinning, pruning, and releasing	Acres	87,300
Growing and distribution of seedling trees for reforestation and wind barriers	Trees	30,000,000
Tree planting and seeding	Acres	76,000
Insect and disease control program	Acres	20,000
Fire control program	Acres	207,000
Cooperative watershed protection and flood prevention	Acres	283,000

The concept of forest management is relatively new to most farmers. These farmers do, however, understand crop management and usually live on or near their land. Many owners lack the capital necessary for stand improvement treatments, planting, or carrying charges, or are uninterested in timber growing. A few individuals are becoming more familiar with intensive forest management practices and see the opportunity to make a profit from their woodlands.

THINNING OF NATIVE PECAN GROVES, SUCH AS THIS ONE IN NEOSHO COUNTY, WILL RESULT IN ECONOMIC NUT PRODUCTION.

Photo by: Kansas State Extension Forester

Except for walnut, very few trees are planted for commercial timber production. Interest in walnut management is increasing. In view of the high value of walnut the planting of this species should be increased. Increased planting of other species is anticipated but not expected to reach large proportions.

Between now and 2000 some reduction is expected in commercial forest areas on bottomlands with about equal increases expected in upland forest acreage. Good results may be expected by the establishment of black walnut and other hardwoods on strip-mined spoil lands.

The net annual growth of sawtimber of all species is expected to increase from 8 million board feet in 1964 to 9 million board feet in 1980, to 11 million board feet in 2000 and to 13 million board feet in 2020. (Exhibit 43) Net growth per acre is also expected to increase.

The annual timber cut of all species from commercial forest lands is expected to increase. This cut is expected to rise from about 5 million board feet in 1964 to 16 million board feet by the year 2020. (Exhibit 43) Ideally, under intensive management, timber stands should be in balance; with cut equal to growth. This ideal situation is not the case in the unit because of the long period of inadequate market resulting in an accumulation of timber volumes in large size trees. Since cut is now much less than growth, it appears that sawtimber cut might be increased 200 percent by 1980 and over 300 percent by 2020.

The unit needs more forest products industries that can use small and low-quality material. The development of more of these industries, such as pulpmills, charcoal, veneer, pallet and cooperage plants, would allow a more effective and complete utilization of the timber resources.

Future crops of high quality hardwood timbers will be in continuing demand and short supply. The projected timber demand to the year 2020 could be met with more intensive forest management and utilization.

Resource Conservation and Development Projects

A large part of the See-Kan Resource Conservation and Development Project is in this unit. This project has been approved for planning. Broad objectives of the project are orderly development of natural resources, establishment of a more balanced economic base, and improvement of the total environment.

Rural Water Districts

Groundwater supplies are generally inadequate for rural domestic and livestock needs in this unit. There is considerable opportunity for development of more rural water districts. (Exhibits 22 and 27)

Although there is potential for use of watershed structures as a source of supply for rural water districts, it appears that the trend is to utilize an existing municipal supply. There is a question as to whether some municipal systems now being expanded to include rural water districts can maintain adequate supplies during severe drought periods. There are towns now supplying rural water districts which have had shortages in the recent past.

Rural Electrification Administration

The discussion on page 69 also applies to the Rural Electrification Administration Program in this unit.

NEOSHO UNIT

IMPACT OF USDA PROGRAMS

Land Treatment Measures

The general discussion beginning on page 225 also applies to the impact of land treatment measures in this unit.

Land treatment benefits from flood reduction in planned watershed projects and those authorized for planning or recommended as early action projects will average $94,100 annually.

Upstream Watershed Projects

The discussion beginning on page 70 also applies to the general impact of watershed development in this unit.

Existing Projects - Floodwater and sediment damages will be reduced to a varying degree for 7,597 acres of floodplain upon completion of the two existing projects. (Exhibit 18) Existing projects include those having attained the status of planning authorization or beyond. Average annual damages will be reduced some 57 percent by these projects. (Exhibit 40) Total expected benefits are as follows:

Flood Damage Reduction	$73,700 1/
Land Enhancement	17,200
Off Project	7,100
Local Secondary	10,300
Total	$108,300

1/ Includes $1,300 from land treatment measures

Average annual cost of structural measures included in existing projects totals $93,000. Comparing total benefits to total costs produces an overall ratio of 1.2:1 for these two projects.

Early Action Projects - Installation of works of improvement, under P.L. 566, in the 21 feasible early action projects will directly benefit 190,541 acres of floodplain lands within the watershed areas. (Exhibit 18) In addition, the

works of improvement will provide benefits to downstream floodplain, outside the watershed boundaries.

It is estimated that average annual flood damages can be reduced 39 percent through installation of land treatment and structural measures in the 21 watersheds. This reduction can be accomplished with a physically and economically feasible system in each watershed. Effects of one such possible system for each watershed are summarized in this report. (Exhibit 41)

Average annual benefits for the 21 watersheds are: flood damage reduction of $1,468,800, of which $92,800 are to land treatment and $1,376,000 to structural measures; recreation (incidental and as a purpose), $606,400; land enhancement, $219,300; off project, $359,400; local secondary, $253,600; and other, $183,100; for a total of $3,090,600.

THIS FLOOD SCENE ON THE COTTONWOOD RIVER IN CHASE COUNTY WILL BE A LESS FREQUENT OCCURRENCE AFTER INSTALLATION OF AUTHORIZED PROJECTS AND PROJECTS RECOMMENDED FOR EARLY ACTION.

Average annual cost of structural measures to be installed in early action projects is $2,099,900. The ratio of total benefits to total costs for these 21 projects is 1.5:1.

Recreation benefits were evaluated for those structures for which estimated costs include storage for recreation use. Seventeen of the reservoirs fall into this category. Combined surface area of recreation pools is estimated to be 4,174 acres.

Long Range Projects - Sixteen additional watershed projects including 2,670 square miles may someday become economically feasible. These projects would benefit 91,889 acres of flood-plain land. Total average annual benefit and cost figures for these projects are:

Benefits	$839,800
Costs	$886,700
Benefit-Cost Ratio	0.9:1

Forest and Grassland Management Programs

The general discussion beginning on page 228 also applies to the impact of forest management in this unit.

Employment in timber-based industries is expected to rise to 810 by the year 2020. (Exhibit 42) Over one-half of the employment will be in the manufacture of primary timber products until after the year 2000. These estimates include timber harvesting, but do not include employment in forest management and protection, nor do they include all secondary manufacturing of timber products. Employment should increase in each category except timber harvesting where greater productivity is taking place and saw and planing mills where many small inefficient mills have quit operating.

Resource Conservation and Development Projects

The general discussion of intangible benefits beginning on page 169 also applies to the impact of resource conservation and development project development in this unit. Monetary benefits of the See-Kan project are currently being evaluated.

Rural Water Districts

The general discussion beginning on page 170 also applies to the impact of rural water districts in this unit.

ECONOMIC DEVELOPMENT

ECONOMIC DEVELOPMENT

Historical Development

Kansas territory was opened for settlement in May of 1854. From the beginning the territory was divided between the North and the South. Many of the early settlers came to fight for or against the extension of slavery and had little interest in tilling the soil or developing a viable economy. After a period of hard and bloody fighting, Kansas entered the Union as a free state in 1861. Little progress was made toward economic or agricultural development until the end of the Civil War in 1865.

The geographical order of development of the study area was from east to west. The first counties were established in the Neosho and Walnut-Verdigris Units in 1855 and the last counties to be organized were in the Upper Arkansas Unit in 1888. The Homestead Act of 1862 hastened the settlement of Kansas lands. In 1863, Congress granted large tracts of land to railroads. These lands were sold to settlers at low prices drawing the immigrants farther westward. The Atchison, Topeka and Santa Fe Railroad ran from Kansas City to Reno County and from there followed the Arkansas River westward across the basin. Construction was completed to Newton in 1871 and on to Colorado by 1873. The few early settlements in the basin were along the railroad and the Arkansas River.

After the Civil War, Texas ranchers and professional drovers began driving cattle northward in search of better markets. In 1872, a branch of the Santa Fe reached Wichita and this became a central shipping point for Texas cattle. Shortly thereafter, the Santa Fe reached Dodge City in Ford County and this town gained historic fame as one of the most important cattle shipping points of this era.

Irrigation development has a long history in southwestern Kansas. The earliest recorded irrigation dates back in 1650 when the Taos Indians settled along Beaver Creek in Scott County. The forerunner to the present irrigation systems began in the late 1800's along the Arkansas River near Garden City. The major difficulty with these early irrigation projects was the uncertainty of water in the Arkansas River. The next step was development of wells to utilize underground water for irrigation. This dates back

to 1908 with a 90 foot well and a four and one-half horse power gasoline engine pumping 120 gallons per minute.

Irrigation has increased steadily in the western one third of the study area and boomed during the drought years of the 1950's. By 1959, there were 559,000 acres of irrigated crops harvested in the study area[1/]. Over 90 percent of this irrigated cropland was located in the Upper Arkansas and Cimarron planning units. Total present irrigation is about 1,340,000 acres. Irrigation can be credited with helping to stabilize the economy of southwestern Kansas.

General Economic and Social Characteristics

This economic analysis is for a 54 county area in southern Kansas. The boundary of this group of counties approximates the Arkansas River drainage area in Kansas. The hydrologic planning units have also been approximated by county boundaries for economic analysis. Henceforth, county delineations will be referred to as study areas and the hydrologic drainage areas as the planning units. (Exhibit 48) The Arkansas River Basin study area contains 28,167,040 acres and the Arkansas drainage basin includes 26,793,747 acres.

The following information describes what has taken place historically in the area, measures the present state of the economy and describes what is expected in the way of future economic activity. Projections are an important tool in detailed resource planning. The more important economic indicators, population, employment and income, are described historically and projected. Other economic and social factors such as migration, education, households, and labor force are only shown historically.

Population

The population of the Arkansas River Basin study area declined from 1930 to 1940, increased slightly from 1940 to 1960, and declined again from 1960 to 1970. The 1970 population estimate was 1,040,340 inhabitants. The total population in 1960 was 14.3 percent higher than the 1930

1/ Reported in the 1959 U.S. Census of Agriculture

population but the 1970 population was only a 12.2 percent increase over 1930.

Urban population increased in each ten year period from 1930 to 1970. The proportion of the population classified as urban also increased steadily. In 1930, 40.8 percent of the total inhabitants lived in cities or towns of 2,500 or more. By 1970, the percentage had increased to 63.5 percent.

The rural population decreased steadily from 548,816 in 1930 to 379,483 in 1970. The rural farm population decreased from 326,642 in 1930 to 112,411 in 1970. During this same period, the rural non-farm population increased from 222,174 in 1930 to 267,072 in 1970. (Exhibits 49 and 50)

The population trends of the Arkansas River Basin study area and the Lower Arkansas study area were dominated by the growth of the Wichita metropolitan area in Sedgwick County. Excluding Sedgwick County, the Arkansas River Basin study area decreased in population each decade between 1930 and 1970. The 1930 population of 790,540 decreased to 689,646 in 1970. In the Lower Arkansas study area, with Sedgwick County excluded, the population increased from 225,749 in 1930 to 236,480 in 1960 and then declined to 225,877 by 1970. The Hutchinson and Newton industrial areas are also in this study area.

Migration

Migration is the primary cause of large population changes within the Arkansas River Basin study area. Birth and death rates influence population changes by a lesser amount. Between 1960 and 1970, the study area had a net out-migration of 106,249 persons. (Exhibit 51) All study areas and all but five counties experienced out-migration during this period. The net out-migration was only 38,350 persons between 1950 and 1960. Though Sedgwick County, the major center of economic growth in the past, had an out-migration of 44,042 between 1960 and 1970 the total population increased 7,463 due to the net reproduction rate. Between 1950 and 1960 Sedgwick County had a net in-migration of 51,555 persons. Excluding Sedgwick County the study area had a net out-migration of 89,505 between 1950 and 1960 and a net out-migration of 62,207 between 1960 and 1970. When the influence of Wichita, Sedgwick

County, is removed it appears that the rate of out-migration is decreasing.

Of the five counties having net in-migration between 1960 and 1970, only three had a significant amount. Crawford County had a net in-migration of 763, Haskell 309, and Lyon 3,041. All of these counties had net out-migration between 1950 and 1960. None of the five counties which had net in-migration between 1950 and 1960 had net in-migration between 1960 and 1970.

Labor Force

The total labor force as defined in the Census of Population includes employed and unemployed civilians as well as members of the Armed Forces. Unemployed persons are civilians 16 years old and older not working but seeking employment. In 1970, the unemployment rate was greater for the study area than for the U.S. because of the relatively high unemployment rates in the Lower Arkansas and Walnut-Verdigris study areas. The labor force to population ratio is expressed as the percent participation. In 1970, the study area experienced a slightly higher average participation rate than did the U.S. This was also true for the three western study areas while the Walnut-Verdigris and the Neosho had participation rates below that for the U.S. (Exhibit 52)

Often it is found that underemployment has a greater impact on the economy of an area than does unemployment. One indicator of underemployment is the number of weeks worked. (Exhibit 53) From the data presented, there is no indication that the study area on the whole is suffering from serious unemployment or underemployment.

The number of persons who worked in 1969 exceeds the total civilian labor force. Part of this difference is due to people in the Armed Forces. The rest is due to the definition of labor force. These figures are not inconsistent. They are different approaches to expressing available manpower.

Employment

The economy of the area is predominantly based on agricultural production, though agricultural employment accounted for only 31 percent of total employment in 1940, 22 percent in 1950, 13 percent in 1960, and 9 percent in 1970. (Exhibit 54) The exception is the Wichita-Newton-Hutchinson industrial area. However, agricultural employment does not include employees of

agricultural supporting firms that are classified as manufacturing, distributive, or service industries.

Total employment increased in the study area between 1940 and 1970. (Exhibit 54) However, the increase between 1960 and 1970 was less than 1 percent while the increase for the U.S. as a whole was nearly 20 percent for the same period. Most of the increased employment between 1940 and 1960 was in the Wichita industrial area where Sedgwick County employment increased at nearly twice the national rate. During the 1960 to 1970 decade though, the Sedgwick County increase was only 6.6 percent--about one-third of the national increase.

Agricultural employment in the study area decreased at a slower rate than the national average. This can partially be attributed to irrigation development in the western part of the study area and partially to off-farm work available to underemployed farmers near growing industrial areas.

Aggregate employment in the non-agricultural sectors increased less than the national average. The average annual rate of increase in manufacturing employment within the study area was over twice the increase in manufacturing employment for the nation between 1940 and 1960 but slightly less than the national rate between 1960 and 1970. The increase in employment in the service sector of the study area was slightly higher than the U.S. increase between 1950 and 1960 but only about half as much during the 1960 to 1970 decade. The rate of change in employment within the study area for individual sectors varied considerably from the national average rate of change for the same sectors.

The general area of employment in which the study area has lagged most as compared with the national average has been the distributive sector. This was caused by decreases in employment in the fields of communications and transportion within the study area.

Income

As a general statement per capita income can be said to reflect the prosperity of an area. People tend to spend approximately 88 percent of their income for goods and services[1/] with the majority of this money being spent in

1/ Developed from data in Survey of Current Business, July 1968, Vol. 48, No. 7, U.S. Department of Commerce, Office of Business Economics, pp. 28-29.

the surrounding community. Each dollar of new money injected into the economy will induce additional spending, thus creating more jobs and increasing the level of income. New money is generated from the primary or basic industries such as agriculture, mining, and manufacturing in the study area. Therefore, the total income of the area is related to the dollar output of these primary industries.

Per capita income in the Arkansas River Basin study area was $2,894 in 1969 compared to $3,139 for the U.S. and median family income was also below that for the U.S. However, the percent of families with annual incomes below the poverty level was less for the study area than for the U.S. This indicates the study area is only slightly below the U.S. with respect to money income.

There is a large variation in income among the individual study areas within the Arkansas River Basin. There is a difference of $510 in annual per capita income between the Cimarron study area and the Neosho study area. There is also a difference of $1,780 in median family income between these two areas and the Neosho study area had 6.2 percent more families with an annual income below poverty level than did the Cimarron study area in 1969.

Annual Per Capita Income, Median Family Income, and Percent of Families with Income under 3,000 Dollars, U.S. and Arkansas River Basin Study Areas, 1969

Area	Annual per capita income	Median family income	Families with annual incomes below the poverty level
	Dollars	Dollars	Percent
United States	3,139	9,590	11.6
Arkansas River Basin	2,894	7,659	10.1
Upper Arkansas	2,691	7,857	10.3
Cimarron	2,948	8,529	9.6
Lower Arkansas	2,838	8,158	8.0
Walnut-Verdigris	2,496	6,716	12.6
Neosho	2,438	6,742	14.2

Source: Bureau of Census

Income is one of the best indicators of economic activity and social well-being for planning purposes. Areas with low income can generally be associated with low levels of education, a high rate of unemployment, and out-migration. These factors have a tendency to remove the more capable section of the labor force to the other areas, leaving the very young and old in the low income area. In this sense, "poverty breeds poverty" and an outside stimulus may be required to alleviate the situation.

In addition to capital investment, a low income area may require investment in human and natural resources. Although water resources development may not be able to stimulate economic activity alone, it is necessary in comprehensive planning to estimate future water needs in light of economic development. Increased economic growth will result in increased population and income. These factors will place a greater demand on water resources within the area.

Projections

Governmental agencies and private industry involved in water resource planning rely on population and employment projections in estimating future water needs. At the national level, population is usually projected first. For small areas better economic indicators are available for estimating employment than for estimating population as estimates of future migration in and out of the area are not required. Employment projections were made for the Arkansas River Basin study area and population projections were developed from these estimates. All projections reflect historical trends and do not consider any study area to have an advantage for economic growth stemming from area development or resource development programs differing from those of the past.

Employment - The preliminary projections developed for the Water Resources Council for use in the 1967 National Assessment of Water Resource were selected as guidelines for projecting employment. As the guidelines used are provisional, the projections for the sub-regions will be subject to change as changes are made for the National Assessment.

It was necessary in making study area projections to first project employment for the state. (Exhibit 55) A

comparison of historical and projected employment was made for the five sectors of the economy for the state and for each study area. (Exhibit 56)

The "Other Commodity Producing" sector of the economy is an aggregation of mining, contract construction, and armed forces. In projecting employment for this sector, armed forces was held constant at the 1960 level.

The Lower Arkansas study area contains the only concentrated industrial complex within the Arkansas River Basin. The majority of the industrial activity is near Wichita. For this reason, the Lower Arkansas study area was divided into two parts for projecting employment. The division was made by removing Sedgwick County. However, the population projections reflect the entire Lower Arkansas study area as the Sedgwick County boundary will not contain the projected growth of the industrial complex over time.

Population - Based on employment projections and projected participation rates for the state of Kansas, it is estimated that the population of the study area will exceed 2,070,000 by the year 2020. This is an increase of 99 percent from the 1970 population of 1,040,340. For this same period it has been estimated that the population of the state of Kansas will also nearly double. (Exhibit 57)

Income - Per capita income projections for Kansas developed by the Office of Business Economics are believed to be the best estimates of future per capita income for the study area. No attempt has been made to estimate future levels of income between planning areas. To do so would require making assumptions about future allocation and productivity of human and natural resources within each area. The Office of Business Economics has projected per capita income for Kansas in constant 1958 dollars to be $3,808 in 1980, $6,724 in 2000, and $11,790 in 2020.

Agriculture

Though employment in agriculture has declined drastically in the study area during the past three decades, the decrease has been at a slower rate than national agricultural employment. Agriculture is still the major industry in the area. It provides a large portion of the primary inputs to the

manufacturing sector of the economy. Much of the industrial activity in the area centers around processing of agricultural products. In addition a large segment of the service sector of the economy is dependent on agriculture. The changing agriculture of the area is important to all sectors of the economy.

Land in Farms

Total land in farms in the study area increased each census year from 1949 to 1964 and then dropped from 1964 to 1969. It ranged from 25,891,260 acres in 1949 to 26,725,769 acres in 1969. The land use category that increased by the largest amount was pastured cropland with an increase of 1,084,014 acres. Total cropland increased by 1,320,019 acres while total woodland decreased by 188,624 and other land decreased by 296,886 acres between 1949 and 1969. (Exhibit 58)

Technological advances have influenced agricultural land use patterns. Improved varieties of seed, larger machinery, and increased use of commercial fertilizers and chemicals allowed the agricultural sector to expand production faster than the rate of increase in demand from our growing population and export market. Government programs plus investment in resource development such as irrigation, drainage, flood protection, and land treatment measures have increased the productivity of the better cropland and forced much of the marginal cropland out of production. This has been a nationwide trend with the study area following this trend.

Crop Production

Cash crops are a major source of direct farm income. Feed crops are also important inputs to the livestock sector. In 1969, wheat was the major cash crop grown in the study area with 5,670,267 acres harvested. This was a decrease of 2,337,355 acres from 1949. Sorghum was the major feed crop in 1969 with 2,144,880 acres being produced, an increase of 699,100 acres over 1949. (Exhibit 59)

Wheat, sorghum, alfalfa, corn, wild hay, soybeans, barley, and oats accounted for 99.0 percent of all cropland

harvested in 1969. This ranged from 98.6 percent of all crops in the Neosho study area to 99.3 percent in the neighboring Walnut-Verdigris study area.

Wheat production accounted for 56.7 percent of the total cropland harvested in the study area. Wheat also was the dominant crop in all of the individual study areas. Sorghum was the second most popular crop in the study area accounting for 21.5 percent of the cropland harvested. Sorghum also ranked second in acres harvested and was the major feed crop produced in each of the individual study areas.

Corn production has been declining in total acres in the study area since 1949. Corn production has also been shifting from the higher rainfall area in the eastern part of the state to the irrigated areas in the southwestern part of the state. The Upper Arkansas and Cimarron study areas increased in corn acreage from 5,484 acres to 157,016 and from 517 acres to 113,459 respectively between 1949 and 1969. In this same time period the three study areas to the east had a decrease in the acres of corn produced. This is an indication that the irrigated areas have a comparative advantage for corn production over the dryland areas.

Livestock and Livestock Products

Livestock and livestock products are of major economic importance in the study area with 70 percent of the cash receipts from farm marketings in 1969 being contributed by the livestock sector. Beef production is the most prominant livestock enterprise covering the entire study area.

The total number of cattle and calves on farms has increased approximately 70 thousand per year since 1949. There has been an increase in all five study areas. (Exhibit 60) Much of the increase has been due to the increased number of breeding animals on farms. Increased feeding operations have also played a major role in the beef industry.

The number of hogs and pigs on farms has varied from year to year among the individual study areas. The number of hogs and pigs in the study area in 1969 was about 675,000--an increase of 45 percent over the 1964 count. Most of the swine production was in the eastern portion of the study area in 1969.

Sheep production is a minor livestock activity within the study area. The majority of the breeding stock is divided among small farm flocks. Dairy and poultry products are also of minor importance in the study area. A large portion of these products are produced for on-farm consumption.

Cash Receipts from Farm Marketings

Total 1969 cash receipts from farm marketing for the study areas were $1,069,948,009. (Exhibit 61) The receipts from sale of livestock and livestock products ranged from 45 percent of total receipts in 1954 to 70 percent in 1969. Cash receipts from both crop and livestock production have increased since 1949. Total cash receipts from farming increased 163 percent between 1949 and 1969. Crop sales increased 65 percent during this period while livestock and livestock product sales increased by 254 percent. However, cash receipts do not reflect a true picture of the value of crop and livestock production as much of the feed grains and hay produced is marketed through livestock.

Number and Size of Farms

One of the major changes in the structure of agriculture in the study area was the consolidation of farms into larger, more efficient units. Individual farm operators were able to operate larger units through the use of larger machinery and mechanization of many labor saving operations. Farm numbers decreased from 62,540 in 1949 to 42,068 in 1969. (Exhibit 62) This was a 32 percent decrease in the number of farms throughout the study area in the 20 year period. During the same period, the average size of farm increased from 414 acres to 636 acres. The change in number and size of farms was not uniform across the study area. The trend actually reversed in the Upper Arkansas and Cimarron areas between 1964 and 1969 due to the widespread conversion of large dryland farms to somewhat smaller irrigated farms.

Farm Tenure

The tenure distribution of farm operators has been shifting from fewer tenants to more part owners within the study area as shown in the following table. The full ownership category was the largest in 1949 accounting for 36 percent of all farm operators. The percentage of full

owners changed little between 1949 and 1969 while part owners increased 11 percent and farm tenants decreased by 11 percent during the same period. The percentage of managers stayed unchanged through 1964 (data was not available for 1969).

Farm Tenure: Arkansas River Basin Study Areas
1949, 1954, 1959, 1964, and 1969

Area and Tenure	1949		1954		1959		1964		1969	
	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.
Arkansas River Basin										
Full Owners	22,363	35.8	20,063	34.8	16,780	33.3	15,157	33.7	15,045	36.0
Part Owners	20,360	32.5	19,813	34.4	19,364	38.5	18,931	42.1	18,336	43.9
Managers	199	.3	162	.3	183	.4	180	.4	1/	1/
Tenants	19,618	31.4	17,599	30.5	13,967	27.8	10,709	23.8	8,407	20.1
All Farm Operators	62,540	100.0	57,637	100.0	50,294	100.0	44,977	100.0	41,788	100.0

Source: U.S. Census of Agriculture
1/ Not delineated in the 1969 U.S. Census of Agriculture

Value of Land and Buildings

The average value of land and buildings per farm in the study area more than tripled between 1949 and 1969. (Exhibit 63) This is partially due to the increase in the market value of land and construction cost of building and partially due to the increase in size of farms. The per acre value of land and buildings increased by 138 percent during this period.

The Lower Arkansas planning area, where the majority of the industrial activity within the study area is located has the highest value per acre. This is an indication of the influence non-agriculture related industry has on the agricultural sector.

Irrigation

Although technological developments have helped to stabilize production, agricultural production and income are still quite variable in the study area. Irrigation increases the stability of agricultural production and income over time and allows for greater control over the physical inputs used in agricultural production than does dryland farming. The majority of irrigation is concentrated in the western part of the study area, the Upper Arkansas and Cimarron study areas. (Exhibit 64) This is primarily due to the lower average annual rainfall and the availability of ground water.

The number of acres irrigated in the study area increased nearly nine fold between 1949 and 1969. A large part of this increase can be attributed to the droughty conditions that prevailed in the early and mid-1950's. It is anticipated that irrigation will continue to increase in the future. The Kansas Water Resources Board has projected irrigated acres by subregions for 1980 and 2000. (Exhibit 69) These projections were used to estimate the cropping pattern, with increased irrigation development, that would meet future agricultural requirements.

Projected Agricultural Production

A "Generalized Analytical Programming Model" was used to estimate the agricultural production in future time periods for the study area. The basic model is a cost minimizing linear programming model.

The programming model was developed for the state rather than to allocate the projected requirements to the study area, as more reliable data were available on a state basis. This allows the model to allocate future production to sub-areas within the study area as well as that portion of the state outside the study area.

Projected requirements for individual crop production in the state of Kansas were based on the projected national requirements for future time periods as adjusted to OBE series "C" population projections. National requirements have been projected for the individual feed grains and food crops of major importance in Kansas. The current normal

production and projected agricultural requirements for the state of Kansas are presented in Exhibit 65.

The land resource base available for agricultural production is projected to decrease over time. It is assumed that additional land will be required for non-agricultural purposes such as transportation, defense, and industrial and residential sites to maintain and perpetuate the economic viability of the study area. The current normal projected agricultural land resource base for crop production by planning units is given in the following table. It is assumed that all classes of agricultural land will be decreased proportionately within planning areas. However, differences are assumed to occur between areas in relation to the economic base of the area.

Current and Projected Cropland Acres
Arkansas River Basin by Planning Units

Area	Acres			
	Current Normal 1/	1980	2000	2020
Hydrologic study area	15,438,854	15,374,564	15,324,728	15,267,000
Planning units				
Upper Arkansas	4,567,597	4,553,939	4,544,792	4,533,000
Cimarron	2,970,754	2,961,877	2,955,908	2,949,000
Lower Arkansas	4,608,204	4,586,131	4,561,348	4,530,000
Walnut-Verdigris	1,455,279	1,446,582	1,442,190	1,440,000
Neosho	1,837,020	1,826,035	1,820,490	1,815,000

1/ Current normal acres are not those for a particular year but are those expected to prevail under present normal conditions. They are based on expanded Conservation Needs Inventory sample data and are not adjusted for drainage area and county differences

Technological Change - Projections of crop yields for 1980, 2000, and 2020, based on past and present research in the state, trends in new technology and projected levels of fertilizer applications were made for each crop by soil resource groups within LRA's. The projected yields are directly related to projected fertilizer requirements so the two cannot be considered independently. (Exhibit 66) These projections further assume the continued application of improved soil and water conservation practices. Production costs associated with the yields were determined.

Crop Production - State sub-area delineations provided the basis for allocating the production by crop to the study area and the planning units. Since linear programming is an optimizing technique (or in this situation cost minimizing) it was necessary to place realistic constraints on the number of acres that could be shifted from one crop to another within each sub-area and also for the shift between sub-areas. This was done on a percentage basis. A lower and upper limit were assigned to each crop.

The programming solutions provide the least cost cropping pattern for the state to meet the projected requirements within the allowable ranges that any one crop can shift from one sub-area to another. This approach enables comparisons to be made between cropping patterns and production by crop within the study area for alternative assumptions with respect to the level of irrigation development. Though only data for the basin is presented here, the analysis also applies to the planning unit cropping patterns that were determined.

Assuming the current normal level of irrigation, with projected state requirements being met, the dryland, irrigated, and total production by crops is given for the study area in Exhibit 67. The increased production shows that increased yields will more than offset decreased cropland acreages. Exhibit 68 shows the level of production that would be expected to be produced in the study area assuming the 1980 and 2000 projected irrigated acreage for the state as determined by the Kansas Water Resources Board. (Exhibit 69)

The production levels in Exhibits 67 and 68 show how increased irrigation is expected to influence crop production in the study area. For example, in 1980 increased irrigation in the state would require wheat production in the study area to be reduced from 187 million bushels to 176 million bushels

if only the projected state requirements are to be met subject to the constraints of the programming model. Production from irrigated land increased for all crops that could be produced on either dry or irrigated cropland, with the exception of alfalfa hay. Production of corn for grain increased from 26 to 34 million bushels in the study area due to increased irrigation in 1980. Dryland production decreased by 4 million bushels while irrigated production increased by 12 million bushels.

Grain sorghum production increased by 51 million bushels on irrigated land and decreased by 35 million bushels on dry-land for a net increase of 16 million bushels for the study area in 1980 due to the projected increase in irrigation in the state. The results of the programming model indicate grain sorghum, wheat, and corn will increase on irrigated land by 1980.

Cropping Patterns - Subject to constraints as used in the model, projected increased irrigation in 1980 would require about 1.5 million acres of additional cropland to remain idle in the study area in meeting the projected state requirements with the least cost cropping pattern. A comparison of the cropping patterns for 1980 and 2000 with and without increased irrigation are given in Exhibits 70 and 71.

Increasing the total number of irrigated acres will generally increase the number of acres of each crop that would be produced on irrigated land. However, comparing the acres of irrigated sorghum silage in 1980 under the two assumptions of irrigation development the program solutions show fewer acres with increased development than with the current normal level. This can be explained in part by the constraints placed on non-irrigated sorghum silage for the two programming solutions. The solution without increased irrigation development had an upper limit of 95 percent on non-irrigated sorghum silage whereas this upper limit was increased to 130 percent for the solution with increased irrigation. However, the 2000 solutions can be compared directly as the same constraints were used for both these solutions.

The optimal programming solutions are intended as guide-lines to what can be expected concerning future cropping

patterns of the study area. Production costs, projected yields, and fertilizer requirements control the sensitivity of the programming model and the solutions. In reality we would not expect the cropping patterns determined by the model to always apply exactly but only to serve as a reference as to the direction of change that can be expected. For example in the 2000 solution with projected irrigation development, irrigated idle cropland is 798,958 acres. (Exhibit 71) Additional land is not expected to be developed for irrigation and then idled. Either less irrigated land will be developed, less dryland will be cropped, or the area will produce more than the base line estimated to production.

Value of Present, Projected, and Potential Production

The value of cropland and grazing land production projected to be produced in the study area was calculated by multiplying the production by the adjusted normalized prices. Value added through enterprises such as livestock production was not included. The value of current normal production was estimated at $439 million. Other estimates are: 1980 production at 683 million; 2000 production at $822 million; and increases above current normal production at 56 percent and 87 percent. (Exhibit 72) With increased irrigation, the value of projected 1980 production was estimated at $695 million and 2020 production at $856 million. Potential production in 1980 was estimated at $794 million. (Exhibit 73)

Economic Impact

Output, income, and employment multipliers derived from the Southern Kansas input-output model and based on the projected 1980 household consumption function provide the best estimates of the impact of resource development as it relates to agricultural production. These multipliers with the effects of local government and households included are assumed to best represent the total impact of future resource development for the study area. Since it is difficult to separate the benefits of the proposed plan of development into crop and livestock benefits the crops multipliers are assumed to be the more representative of the aggregate agricultural benefits. It is estimated that for each additional one dollar of crop production $2.83 of total output will be generated in the study area.

The direct annual benefits from early action programs was estimated to be $5,153,700. Of this amount approximately $2,913,800 was direct agricultural benefits, primarily increased income relating to agricultural production. Applying our output multiplier of 2.83 the total impact would be $8,246,100 ($2,913,800 x 2.83). The estimated agricultural benefits for the planning units are as follows:

Planning Unit	Direct Annual Agricultural Benefits	Increased Output
Cimarron	--	--
Upper Arkansas	1,050,000	2,971,500
Lower Arkansas	242,500	686,300
Walnut-Verdigris	1,566,000	4,431,800
Neosho	55,300	156,500
Study Areas	2,913,800	8,246,100

Increased output is only one measure of the impact of resource development. Assuming additional income generated from the increase in output is spent in the same proportions as other income from crops the income multipliers can be used to estimate the impact on total income for the area. It is estimated that for each dollar of crop output $.47 goes to households as salaries, wages, and retained earnings. Income multipliers based on the projected 1980 household consumption function is 1.90. Therefore, the total impact on area income resulting from increased agricultural production is estimated to be $2,602,000 ($2,913,800 x .47 x 1.90).

Increased output can be translated into employment by using projected employment output ratios and the 1980 employment multipliers. It was projected that 29.592 persons would be employed in 1980 for each $1,000,000 of output from the crops sector. Each new employee in the crops sector would generate employment for 1.622 persons in the remaining sectors of the economy.

The total impact on employment resulting from the increase in agricultural output associated with the early action programs is estimated to be 226 (2.9138 x 29.592 x 2.6222) employees.

Direct benefits of recreation associated with resource development were estimated by the Soil Conservation Service by multiplying recreation occasions by $1.50. Multipliers for the trade and service sectors, based on the projected 1980 household consumption function, were used to estimate the impact of recreation. A recreation sector as such was not included in the Southern Kansas input-output matrix.

Annual direct recreation benefits associated with the early action programs were estimated at $1,032,500. The recreation output multiplier is estimated to be 2.83. Therefore, the impact of recreation on total output of the area economy is estimated to be $2,973,600. Using the same procedure as for agricultural output, the impact on area income from recreation is estimated at $961,300.

Water multipliers define the change in total water requirements in the economy as a result of a one gallon change in direct water requirements in water using sectors. Water multipliers were estimated for two water use categories (1) instream and withdrawal, and (2) withdrawal only.

The metal, machinery and equipment sector had the largest water multiplier (8.43)for the instream and withdrawal category, but agricultural processing had the largest Type II water multiplier (4.74) for the withdrawal category.

The agricultural processing sector had either the largest or second largest multipliers for all of the multiplier classification estimated. This was due to the definition of sectors, the industrial mix, and the interdependence between sectors in the study area. These conclusions would not necessarily apply if any of the above conditions were to be altered.

Using coefficients developed from the southern Kansas input-output model total annual water requirements, excluding irrigation, for the study area were projected to be 305,588, 419,732, and 607,318 million gallons for 1980, 1990, and

2000 respectively. For the same target years only 128,799, 163,620, and 220,089 million gallons were projected to be withdrawal water requirements with the balance projected as instream water requirements.

COORDINATION and PROGRAMS
for
FURTHER DEVELOPMENT

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Relationship of Interest Rate to Potential P.L. 566 Development

Water Resources Council rule 704.39 establishes the basis for computation of interest rate to be used by federal agencies in formulation and evaluation of plans for water and related land resources. Fiscal year 1969 was the first year in which the discount rate was computed under this rule. The fiscal year 1969 rate was 4 5/8 percent. The rate in effect immediately before was 3 1/4 percent.

Average annual project costs were in effect raised nearly 40 percent by this change in discount rate (based upon a 100 year amortization period). Benefits did not go up materially because evaluation procedures did not change and prices received for farm products did not go up. The net effect was a reduction in number of feasible projects. A potential project evaluated at 1.4:1 benefit-cost ratio in fiscal year 1968 was barely justified when re-evaluated in fiscal year 1969.

Water Resources Council rule 704.39 also provides that the interest rate be recomputed annually but may not change more than 1/4 of one percent per year. In fiscal year 1970 the new rate was established at 4 7/8 percent. In 1971 the rate was 5 1/8 percent, 5 3/8 percent in 1972, and the rate for 1973 has been set at 5 1/2 percent. This trend is expected to continue for several more years. Generally the result will be a continued reduction in the number of economically feasible projects. The following tabulation shows the effect of this trend without some change in the factors involved:

Number of Feasible P.L. 566 Projects[1]

Interest Rate (%)	Upper Arkansas Unit	Cimarron Unit	Lower Arkansas Unit	Walnut-Verdigris Unit	Neosho Unit	Total Basin
3 1/4	24	3	8	26	38	99
4 5/8	23	-	7	14	33	77
4 7/8	22	-	7	12	28	69
5 1/8	22	-	7	8	22	59
5 3/8	13	-	6	6	22	47
5 1/2	13	-	5	6	22	46
5 3/4	13	-	5	3	20	41

1/ Does not include watersheds authorized for installation

Accelerated P.L. 566 Project Installation

The rate of P.L. 566 project development should be accelerated. The program has proven its merit and attracted many applications for assistance. Project sponsors are willing to meet their obligations. Enthusiasm has been maintained in spite of the long delay encountered as a normal part of development of this type. Abnormal delays encountered because of lack of construction funds have caused an undue test of sponsors patience. This is a serious threat to the continued success of the program. Many fine local leaders will be lost if acceleration of project installation does not come soon.

An increase in federal funding is needed to accomplish installation of watershed projects in the following categories by 1990:

1. Currently authorized for installation
2. Currently authorized for planning
3. Proposed as early action projects

Total federal project costs for installation of these projects is estimated to be $123 million. Twenty eight million dollars of installation have been obligated through fiscal year 1972. Appropriations will need to be made at the rate of $5.3 million per year within the Arkansas River Basin in Kansas if the remaining $95 million is to be obligated by 1990. Funding may be accomplished through: an increase in P.L. 566 appropriations; through basin authorizations brought about by needs demonstrated in this report; or by a combination of the two methods. Exhibit 74 demonstrates graphically a schedule of federal funding to accomplish this job.

Projects or Programs Needed

The primary need in the Upper Arkansas and Cimarron Units is more efficient water use. Innovations in existing programs and new programs will have to be developed to meet this need. Another need which will require new programs is that of artificial recharge. The present research should be continued to develop the necessary information to implement artificial recharge. Water-based recreation is another need which is not being met in this unit by present programs. This is partly due to the lack of reservoir sites and runoff but there are a few sites which could be utilized to increase the amount of recreation water available. A new approach to financing will probably have to be developed. The 1965 flood showed the need for one or more major reservoirs on the main-stem Arkansas River. These would be multi-purpose reservoirs serving several functions.

There will be a need for major multi-purpose reservoirs in the Lower Arkansas Unit for flood control and also for water supply for the major metropolitan areas. It may be feasible to divert some of the streams around areas of natural pollution so as to enhance the fresh-water supplies. It may also be desirable to impound the waters below areas of natural pollution in large reservoirs from which the poor quality water may be released during high flow periods.

There will be a need for major multi-purpose reservoirs primarily for flood control in the Walnut-Verdigris and Neosho Units. There is also a possibility that the development of nuclear power plants will demand water storage in large reservoirs for cooling purposes.

Coordination of Programs

An effective program to promote more efficient water use will require coordination between the Department of Agriculture, the Bureau of Reclamation, the Extension Service, and several state agencies. The Soil Conservation Service should expand their Irrigation Water Management Program to make it more generally applicable. An irrigation scheduling program on an area-wide basis should be investigated. The work of the Bureau of Reclamation on efficiency in irrigation should be expanded to include the basin. The education efforts of the Extension Service should be expanded and strengthened to emphasize efficient water use. Cost sharing should be broadened for water saving measures such as the installation of meters and tailwater recirculating systems. Tax incentives should be offered by the state to encourage the adoption of water-saving measures.

The Corps of Engineers is completing a comprehensive study of the Upper Arkansas River above Great Bend. This study will consider projects for authorization. Close coordination between the Corps and the Soil Conservation Service should be maintained.

The Corps of Engineers is engaged in making a comprehensive study of the Lower Arkansas, Walnut-Verdigris, and Neosho Units. Preliminary results from this study indicate that the extension of navigation appears to be feasible up to Wichita. The final report will consider projects for authorization and thus close coordination among all agencies is essential.

Some of the needs in this unit can be met by Soil Conservation Service, Corps of Engineers, or Bureau of Reclamation programs individually and others can be satisfied by complementary programs involving either two or all three of the agencies. There will be many opportunities for exchange of benefits between upstream watershed developments and major reservoirs. It is important that coordinated planning, development, and operation of projects be continued on an integrated, basin-wide basis.

USDA-SCS-LINCOLN, NEBR. 1975

EXHIBITS

Arkansas River Basin - Kansas
Exhibit 1 - Basin Area in each County

County	Acres of County in Basin	
Upper Arkansas Unit		
Barton	173,932	
Edwards	213,369	
Finney	833,280	
Ford	573,648	
Gray	401,376	
Greeley	413,197	
Hamilton	502,735	
Haskell	102,580	
Hodgeman	550,400	
Kearny	483,549	
Kiowa	17,269	
Lane	374,132	
Ness	594,302	
Pawnee	459,724	
Rush	296,423	
Scott	311,525	
Stafford	28,854	
Wichita	276,327	
Unit Total		6,606,622
Cimarron Unit		
Morton	465,920	
Stanton	432,640	
Hamilton	132,145	
Grant	365,440	
Stevens	467,840	
Seward	413,440	
Haskell	268,620	
Gray	157,344	
Meade	626,560	
Clark	623,724	
Ford	72,254	
Kiowa	46,989	
Comanche	203,905	
Kearny	67,491	
Unit Total		4,344,312

Arkansas River Basin - Kansas
Exhibit 1 - Basin Area in each County

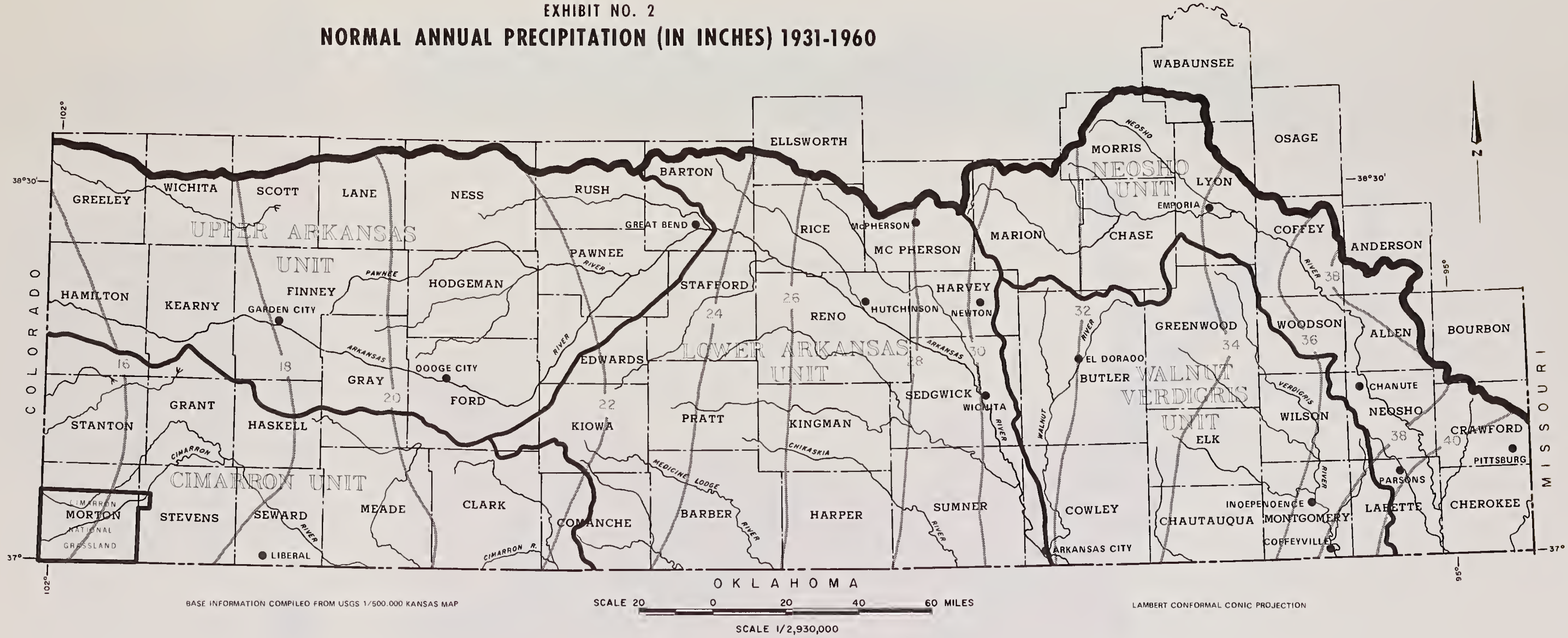
County	Acres of County in Basin	
Lower Arkansas Unit		
Barber	733,440	
Barton	312,124	
Clark	6,036	
Comanche	308,095	
Cowley	98,786	
Edwards	182,791	
Ellsworth	69,171	
Ford	52,338	
Harper	512,640	
Harvey	275,257	
Kingman	553,600	
Kiowa	396,542	
Marion	21,289	
McPherson	327,823	
Pawnee	23,476	
Pratt	466,560	
Rice	451,652	
Reno	807,680	
Rush	4,253	
Sedgwick	581,328	
Stafford	479,946	
Sumner	759,279	
Unit Total		7,424,106
Walnut-Verdigris Unit		
Butler	909,341	
Chase	28,391	
Chautauqua	414,080	
Cowley	630,174	
Elk	414,080	
Greenwood	715,529	
Harvey	56,116	
Labette	162,822	
Lyon	52,031	
Marion	20,488	
Montgomery	415,360	
Neosho	33,858	
Sedgwick	63,792	
Sumner	401	
Wilson	345,860	
Woodson	114,944	
Unit Total		4,377,267

Arkansas River Basin - Kansas
Exhibit 1 - Basin Area in each County

County	Acres of County in Basin	
Neosho Unit		
Allen	261,859	
Anderson	71,872	
Bourbon	10,368	
Butler	15,459	
Chase	466,969	
Cherokee	375,680	
Coffey	334,280	
Crawford	312,457	
Greenwood	20,471	
Harvey	14,227	
Labette	255,738	
Lyon	381,061	
Marion	530,791	
McPherson	12,778	
Morris	357,282	
Neosho	341,822	
Wabaunsee	49,210	
Wilson	21,500	
Woodson	207,616	
Unit Total		4,041,440
Basin Total		26,793,747

EXHIBIT NO. 2

NORMAL ANNUAL PRECIPITATION (IN INCHES) 1931-1960



USDA-SCS-LINCOLN, NEBR. 1972

12-11-70
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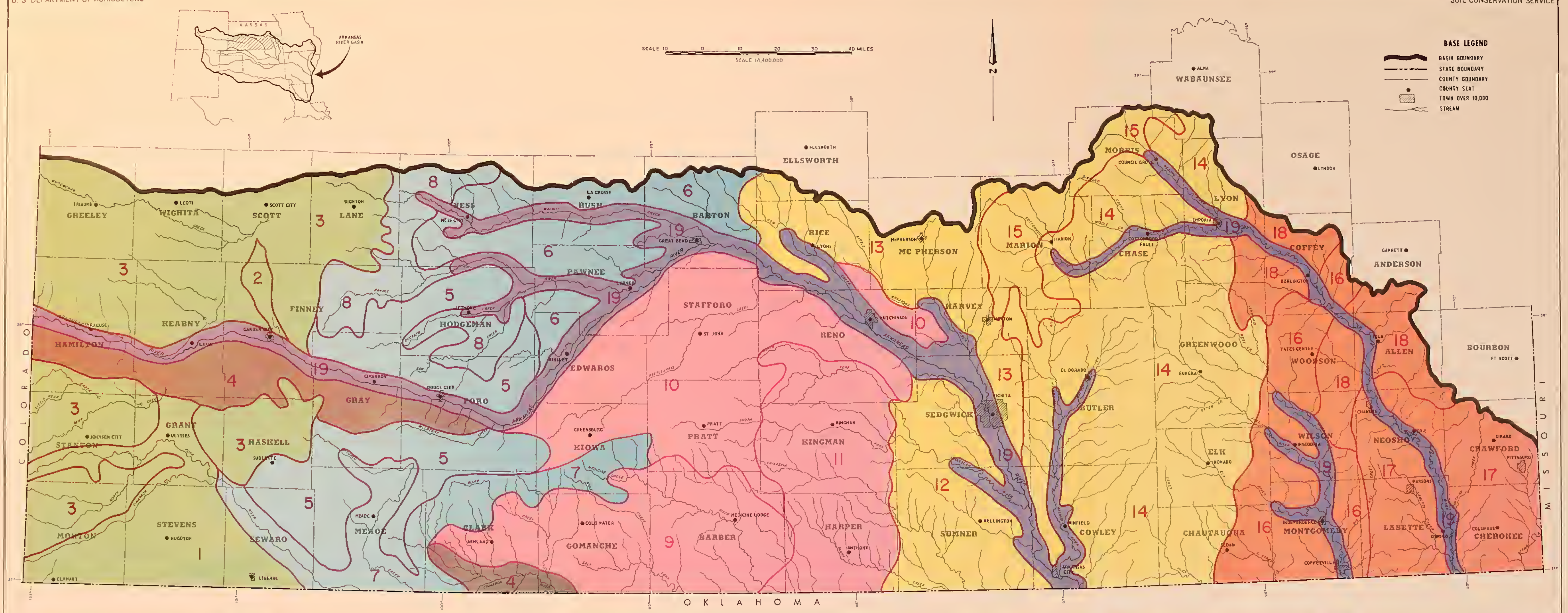
EXHIBIT NO. 2

U S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



	WELL DRAINED AND SOMEWHAT POORLY DRAINED SOILS FORMED IN LOESS AND WIND DEPOSITED, SANDY MATERIALS (ARIDIC USTALFS · ARIDIC USTOLLS · USTIC ORTHENTS)
1	DALHART-MANTER ASSOCIATION: DEEP NEARLY LEVEL TO DUNY, SANDY SOILS THIS ASSOCIATION LACKS A WELL DEFINED DRAINAGE PATTERN IT IS A MAJOR GRAIN SORGHUM PRODUCING AREA WHEAT IS ANOTHER IMPORTANT CROP IN THE ASSOCIATION THE DUNY AREAS ARE USED FOR RANGE SOIL BLOWING IS THE MAJOR PROBLEM
2	DRUMMOND-ULYSSES SALINE ASSOCIATION: DEEP, NEARLY LEVEL, LOAMY SALINE AND ALKALI SOILS DRAINAGE IS INTO LOCAL DEPRESSIONS THE SOILS MOST SEVERELY AFFECTED BY SALT AND ALKALI ARE USED FOR RANGE WHEAT AND GRAIN SORGHUM ARE GROWN ON THE LESS SEVERELY AFFECTED SOILS THE MAJOR PROBLEMS ARE THE SALT AND ALKALI AND SOIL BLOWING
3	RICHFIELD ULYSSES-COLBY ASSOCIATION: DEEP NEARLY LEVEL TO SLOPING LOAMY SOILS THE BROAD PLAINS IN THIS AREA DRAIN INTO LOCAL DEPRESSIONS THERE ARE A FEW WELL DEFINED DRAINAGEWAYS WHEAT AND GRAIN SORGHUM ARE THE MAJOR CROPS THE SOILS ARE WELL SUITED FOR IRRIGATION THE MAJOR PROBLEMS ARE SOIL BLOWING AND WATER EROSION
	EXCESSIVELY DRAINED AND WELL DRAINED SOILS FORMED IN WIND DEPOSITED SANDS (TYPIC PSAMMENTS · USTOLLIC ARGIDS)
4	TIVOLI-VONA ASSOCIATION: DUNY TO HUMMOCKY, SANDY SOILS. THIS AREA LACKS A WELL DEFINED DRAINAGE PATTERN MUCH OF THE ASSOCIATION IS USED FOR RANGE GRAIN SORGHUM IS GROWN ON SOME OF THE HUMMOCKY SOILS BUT SOIL BLOWING IS A PROBLEM
	WELL DRAINED AND MODERATELY WELL DRAINED SOILS FORMED IN LOESS, MATERIAL WEATHERED FROM CHALKY LIMESTONE, AND LOAMY OUTWASH (TYPIC USTOLLS · LITHIC ORTHENTS)
5	HARNEY-SPEARVILLE-ULY ASSOCIATION: DEEP NEARLY LEVEL TO SLOPING, LOAMY AND CLAYEY SOILS THE NEARLY LEVEL AREAS DRAIN INTO LOCAL DEPRESSIONS. THE SLOPING SOILS ARE MOSTLY ALONG DRAINAGEWAYS. MOST OF THE ASSOCIATION IS CULTIVATED TO WHEAT AND GRAIN SORGHUM. SOIL BLOWING AND WATER EROSION ARE THE MAJOR PROBLEMS
6	HARNEY WAKEEN ASSOCIATION: DEEP AND MODERATELY DEEP, NEARLY LEVEL TO ROLLING, LOAMY SOILS MUCH OF THIS AREA HAS A WELL DEFINED DRAINAGE PATTERN WHEAT AND GRAIN SORGHUM ARE THE MAJOR CROPS. THE ROLLING AREAS ARE USED FOR RANGE WATER EROSION IS THE MAJOR PROBLEM IN THE AREA.
7	MANSIC-POTTER ASSOCIATION: DEEP TO SHALLOW, GENTLY SLOPING TO HILLY, LOAMY SOILS. THIS AREA HAS A WELL DEFINED DRAINAGE PATTERN THE SHALLOW, HILLY SOILS ARE USED FOR RANGE BUT MANY OF THE DEEP GENTLY SLOPING SOILS ARE CROPPED TO WHEAT AND GRAIN SORGHUM WATER EROSION IS THE MAIN PROBLEM IN THE AREA
8	PENDEN-CANLON ASSOCIATION: DEEP TO SHALLOW, GENTLY SLOPING TO HILLY LOAMY SOILS THIS AREA HAS A WELL DEFINED DRAINAGE PATTERN THE SHALLOW HILLY SOILS ARE USED FOR RANGE BUT MANY OF THE DEEP, GENTLY SLOPING SOILS ARE CROPPED TO WHEAT AND GRAIN SORGHUM WATER EROSION IS THE MAIN PROBLEM IN THE AREA
	WELL DRAINED AND SOMEWHAT POORLY DRAINED SOILS FORMED IN OLD ALLUVIUM, MATERIALS WEATHERED FROM SHALE, AND WIND DEPOSITED SANDY MATERIALS (UDIC USTOLLS · PSAMMENTIC USTALFS)
9	ALBION WOODWARD-VERNON ASSOCIATION: MODERATELY DEEP AND SHALLOW, GENTLY ROLLING TO HILLY, SANDY AND LOAMY SOILS. THIS ASSOCIATION HAS A WELL DEFINED DRAINAGE PATTERN MUCH OF THE ASSOCIATION IS USED FOR RANGE BUT SOME OF THE GENTLY ROLLING SOILS ARE CROPPED TO WHEAT AND GRAIN SORGHUM WATER EROSION IS THE MAJOR PROBLEM.
10	PRATT-NARON-CARWILE ASSOCIATION: DEEP, NEARLY LEVEL TO HUMMOCKY SANDY AND LOAMY SOILS. MOST OF THIS ASSOCIATION LACKS A WELL DEFINED DRAINAGE PATTERN WHEAT AND GRAIN SORGHUM ARE THE MAJOR CROPS. THERE ARE SOME DUNY AREAS IN THE ASSOCIATION THAT ARE USED FOR RANGE. SOIL BLOWING IS THE MAIN PROBLEM BUT DRAINAGE IS A PROBLEM ON SOME OF THE NEARLY LEVEL SOILS.
11	SHELLABARGER DRANE-NASHVILLE ASSOCIATION: DEEP AND MODERATELY DEEP, NEARLY LEVEL TO SLOPING, SANDY AND LOAMY SOILS. THIS AREA HAS A WELL DEFINED DRAINAGE PATTERN WHEAT AND GRAIN SORGHUM ARE THE MAJOR CROPS. THE ASSOCIATION INCLUDES SOME HILLY AREAS THAT ARE USED FOR RANGE WATER EROSION IS THE MAIN PROBLEM IN THE AREA.
	WELL DRAINED AND MODERATELY WELL DRAINED SOILS FORMED IN LOESS, OLD ALLUVIUM, AND MATERIALS WEATHERED FROM LIMESTONE AND SHALE (PACHIC USTOLLS · UDIC USTOLLS)
12	BETHANY-VANOSS-TABLER ASSOCIATION: DEEP, NEARLY LEVEL TO SLOPING LOAMY AND CLAYEY SOILS THIS ASSOCIATION HAS A WELL DEFINED DRAINAGE PATTERN MOST OF IT IS CROPPED TO WHEAT AND GRAIN SORGHUM. WATER EROSION IS THE MAIN PROBLEM ON SLOPING SOILS THAT ARE CULTIVATED SOME OF THE NEARLY LEVEL SOILS HAVE SLOW SURFACE DRAINAGE.
13	CRETE-GEARY ASSOCIATION: DEEP, NEARLY LEVEL TO SLOPING, CLAYEY AND LOAMY SOILS THIS ASSOCIATION HAS A WELL DEFINED DRAINAGE PATTERN MOST OF THE AREA IS CROPPED TO WHEAT AND GRAIN SORGHUM. THE MAIN PROBLEM IS WATER EROSION
14	IRWIN LABETTE-FLORENCE ASSOCIATION. DEEP AND MODERATELY DEEP, GENTLY SLOPING TO HILLY, CLAYEY SOILS THIS AREA IS WELL DISSECTED BY DRAINAGEWAYS. THE PREDOMINANT USE IS FOR RANGE GRAIN SORGHUM, WHEAT, AND SOYBEANS ARE GROWN ON SOME OF THE GENTLY SLOPING SOILS WATER EROSION IS THE MAIN PROBLEM
15	LADYSMITH-ROSEHILL ASSOCIATION: DEEP AND MODERATELY DEEP, NEARLY LEVEL TO ROLLING, CLAYEY SOILS MOST OF THE AREA IS WELL DISSECTED BY DRAINAGEWAYS. THE NEARLY LEVEL TO SLOPING SOILS ARE CROPPED TO WHEAT AND GRAIN SORGHUM. THE ROLLING SOILS ARE USED FOR RANGE. WATER EROSION IS THE MAIN PROBLEM ON THE SLOPING SOILS THAT ARE CULTIVATED. SOME OF THE NEARLY LEVEL SOILS HAVE SLOW SURFACE DRAINAGE
	SOMEWHAT POORLY DRAINED TO WELL DRAINED SOILS FORMED IN MATERIALS WEATHERED FROM SHALE AND SANDSTONE, AND IN OLD ALLUVIUM. (AQUIC UDOLLS · MOLLIC AQUALFS · ABRUPTIC AQUOLLS)
16	DENNIS-BATES-DARNELL ASSOCIATION: DEEP TO SHALLOW, GENTLY SLOPING TO HILLY CLAYEY AND LOAMY SOILS. THIS AREA IS WELL DISSECTED BY STREAMS. WHEAT, GRAIN SORGHUM, CORN, AND SOYBEANS ARE GROWN IN THE ASSOCIATION THE HILLY, SHALLOW SOILS HAVE A MIXED VEGETATION OF GRASS AND TREES AND ARE USED FOR GRAZING OR TIMBER WATER EROSION IS A PROBLEM IN CULTIVATED AREAS.
17	PARSONS-DENNIS-BATES ASSOCIATION: DEEP AND MODERATELY DEEP, NEARLY LEVEL TO ROLLING, CLAYEY AND LOAMY SOILS THIS ASSOCIATION HAS A WELL DEFINED DRAINAGE PATTERN SOYBEANS WHEAT, CORN, AND GRAIN SORGHUM ARE THE MAJOR CROPS. THE ROLLING AREAS ARE USED FOR RANGE. IN CULTIVATED AREAS WATER EROSION IS A PROBLEM ON THE SLOPING SOILS SOME OF THE NEARLY LEVEL SOILS HAVE SLOW SURFACE DRAINAGE
18	WOODSON-SUMMIT-KENOMA ASSOCIATION: DEEP NEARLY LEVEL TO ROLLING, CLAYEY SOILS THIS AREA HAS A WELL DEFINED DRAINAGE PATTERN SOYBEANS, CORN, WHEAT, AND GRAIN SORGHUM ARE THE MAIN CROPS THE ROLLING AREAS ARE USED FOR RANGE WATER EROSION IS THE MAIN PROBLEM IN CULTIVATED AREAS ON THE SLOPING SOILS SLOW SURFACE DRAINAGE IS A PROBLEM ON SOME OF THE NEARLY LEVEL SOILS
	WELL DRAINED TO POORLY DRAINED SOILS FORMED IN ALLUVIUM (CUMULIC & FLUVENTIC USTOLLS & UDOLLS · TYPIC & AQUIC FLUVENTS · FLUVENTIC & VERTIC AQUOLLS)
19	SOILS OF THE FLOOD PLAINS AND TERRACES NEARLY LEVEL SANDY LOAMY, AND CLAYEY SOILS THE SUITABILITY OF THESE SOILS FOR CROPS VARIES WITH THE SOIL CHARACTERISTICS AND THE AMOUNT OF FLOODING THE LOAMY SOILS ON TERRACES ARE SUITED TO ALL LOCALLY ADAPTED CROPS DRAINAGE IS A PROBLEM ON THE CLAYEY SOILS THE SANDY SOILS BLOW EASILY AND HAVE LOW WATER HOLDING CAPACITY

GENERAL SOIL MAP

ARKANSAS RIVER BASIN

(KANSAS PORTION)

RIVER BASIN STUDY

USDA SCS

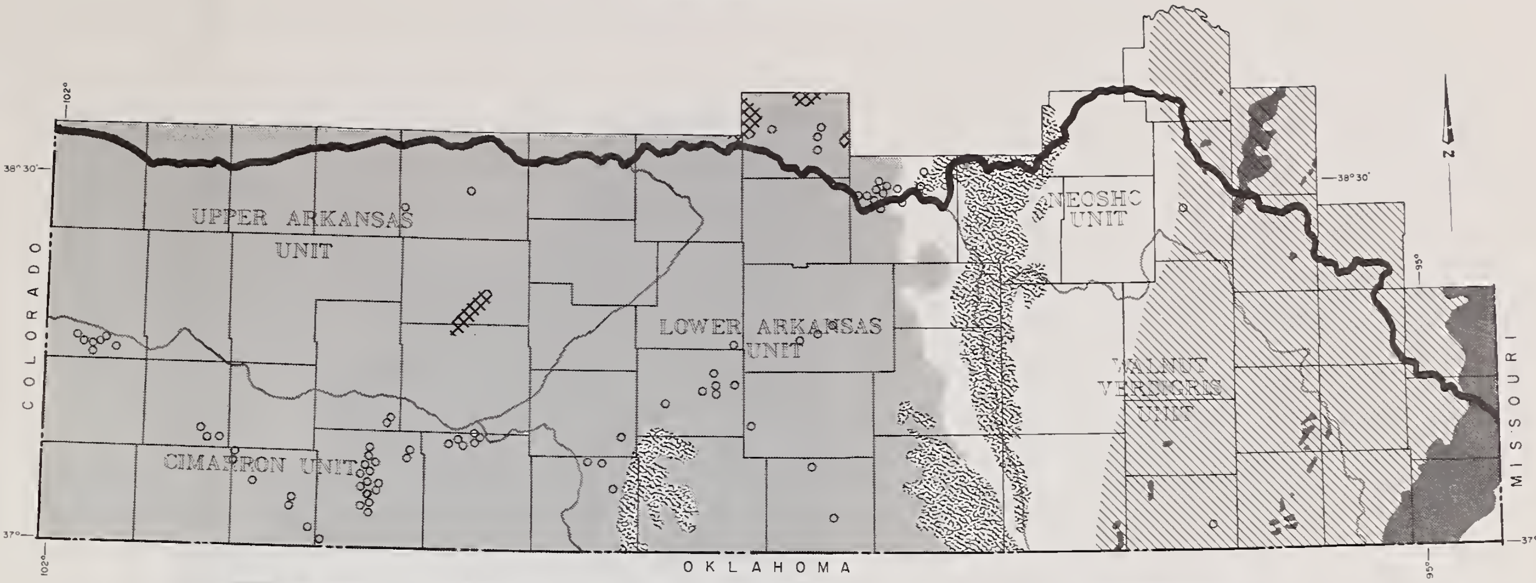
SOURCE
USGS 1/500,000 BASE MAP AND
INFORMATION FROM FIELD

LAMBERT CONFORMAL CONIC PROJECTION

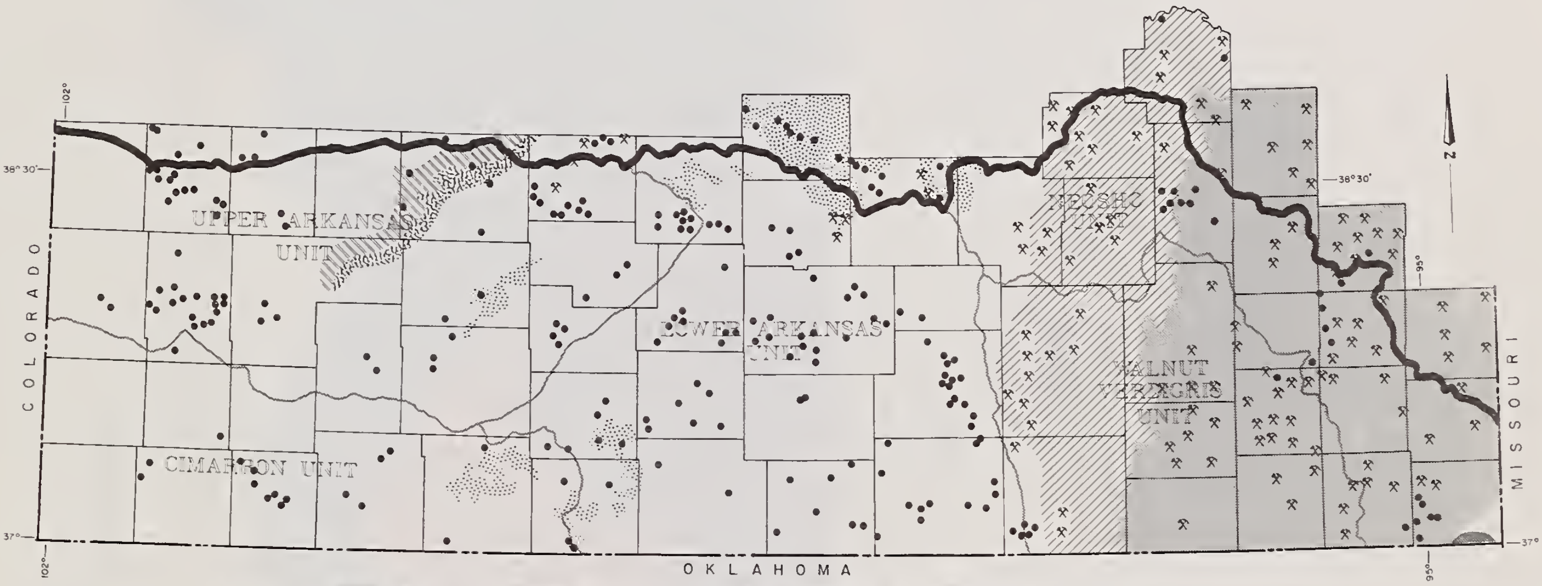
3-1-71
5,5-28,541.14

EXHIBIT NO 3

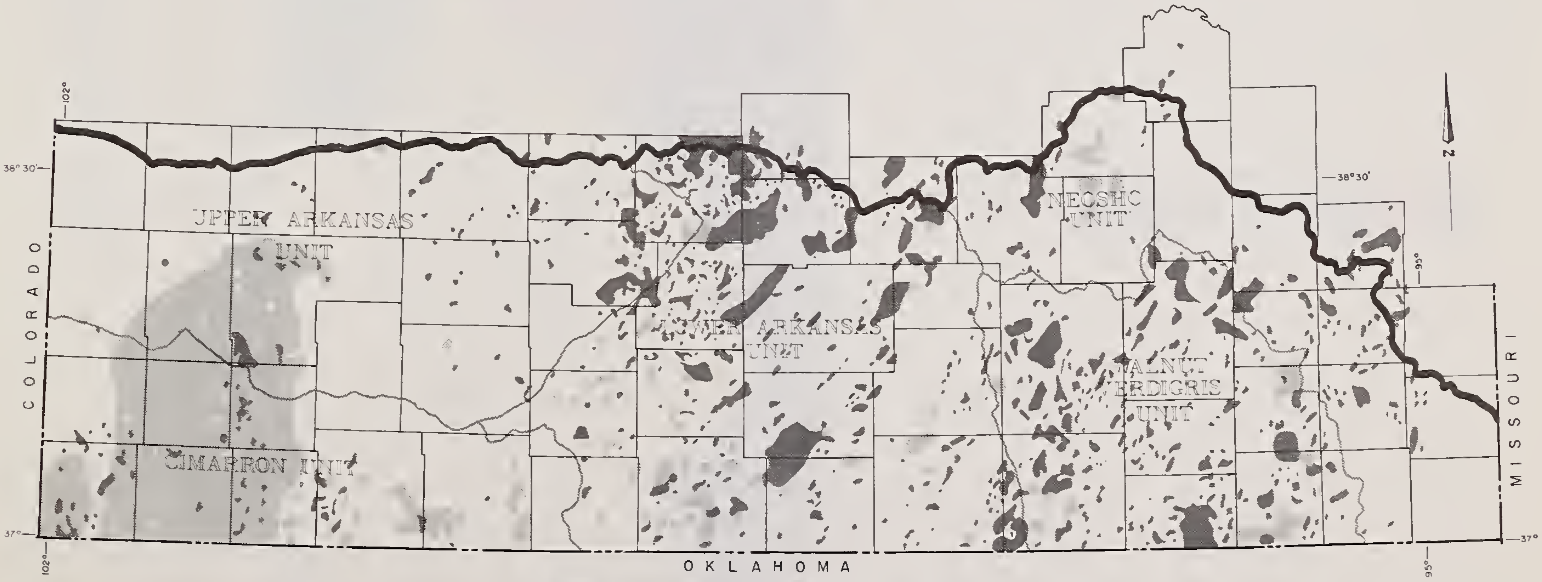
Exhibit No. 4
MINERAL RESOURCES



AREA UNDERLAIN BY SALT DEPOSITS
AREA UNDERLAIN BY GYPSUM DEPOSITS
VOLCANIC ASH DEPOSIT
BITUMINOUS COAL PRODUCING AREA
AREA OF FORMER LIGNITE MINES
AREA CONTAINING BITUMINOUS COAL BEDS



STONE QUARRY
SAND-GRAVEL PIT
PENNSYLVANIAN LIMESTONES AND SHALES FOR CEMENT, CLAY AND ROCK PRODUCTS
PERMIAN LIMESTONES FOR BUILDING STONE, AGGREGATE, CEMENT
LIGHTWEIGHT CONCRETE AGGREGATE AND OTHER CERAMIC PRODUCTS
CRETACEOUS CLAYS AND SHALES FOR BRICK, TILE
OUTCROP AREA OF FORT HAYS CHALK
ZINC-LEAD AREA



GAS PRODUCING AREAS
OIL PRODUCING AREAS

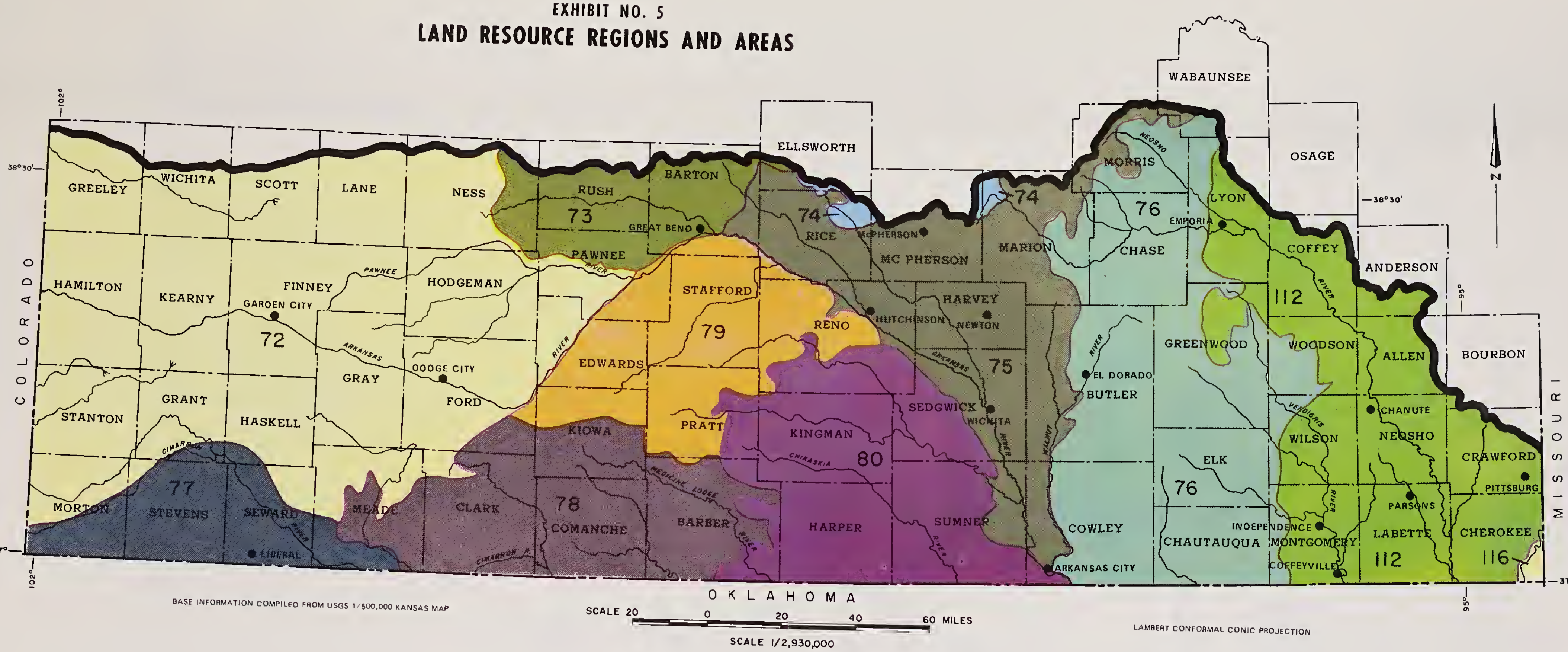
SCALE 20 0 20 40 60 MILES
SCALE 1/3,870,000

Source: Kansas Geological Survey

EXHIBIT NO. 4

EXHIBIT NO. 5

LAND RESOURCE REGIONS AND AREAS



LEGEND

CENTRAL GREAT PLAINS WINTER WHEAT AND RANGE REGION

- 72 Central High Tableland
- 73 Rolling Plains and Breaks
- 74 Central Kansas Sandstone Hills
- 75 Central Loess Plains
- 76 Bluestem Hills
- 77 Southern High Plains
- 78 Central Rolling Red Plains
- 79 Great Bend Sand Plains
- 80 Central Rolling Red Prairies

CENTRAL FEED GRAINS AND LIVESTOCK REGION

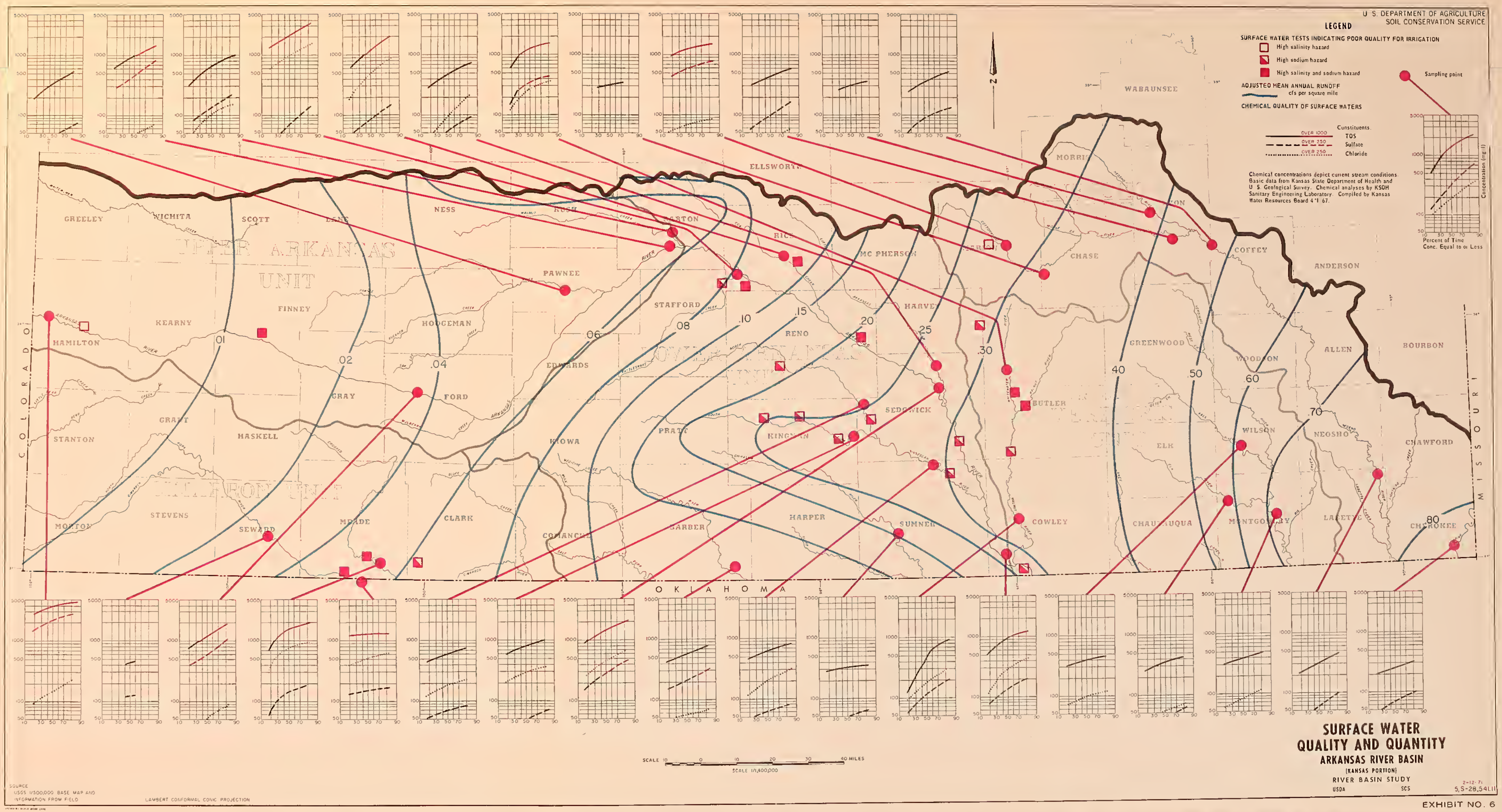
- 112 Cherokee Prairies

EAST AND CENTRAL GENERAL FARMING AND FOREST REGION

- 116 Ozark Highland

USDA-SCS-LINCOLN, NEBR. 1972

12-4-70
5,0-28,6162


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LEGEND
SURFACE WATER TESTS INDICATING POOR QUALITY FOR IRRIGATION
High salinity hazard
High sodium hazard
High salinity and sodium hazard
Sampling point
ADJUSTED MEAN ANNUAL RUNOFF
cfs per square mile
CHEMICAL QUALITY OF SURFACE WATERS
Constituents
OVER 1000 TDS
OVER 250 Sulfate
OVER 250 Chloride
Chemical concentrations depict current stream conditions. Basic data from Kansas State Department of Health and U. S. Geological Survey. Chemical analyses by KSDH Sanitary Engineering Laboratory. Compiled by Kansas Water Resources Board 4-1-67.
Concentration (mg/l)
Percent of Time Conc. Equal to or Less
UPPER ARKANSAS UNIT
LOWER ARKANSAS UNIT
CIMARRON UNIT
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
ELLSWORTH
RICE
MC PHERSON
MARION
MORRIS
WABAUNSEE
CHASE
COFFEY
ANDERSON
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
STAFFORD
RENO
HARVEY
BUTLER
GREENWOOD
WOODSON
ALLEN
BOURBON
STANTON
GRANT
HASKELL
GRAY
FORD
EDWARDS
KIOWA
PRATT
KINGMAN
SEDGWICK
ELK
WILSON
NEOSHO
CRAWFORD
MORTON
STEVENS
SEWARD
MEADE
CLARK
COMANCHE
BARBER
HARPER
SUMNER
COWLEY
CHAUTAUQUA
MONTGOMERY
LABETTE
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SCALE 1:1,400,000
SOURCE
USGS 1:500,000 BASE MAP AND INFORMATION FROM FIELD
LAMBERT CONFORMAL CONIC PROJECTION
SURFACE WATER
QUALITY AND QUANTITY
ARKANSAS RIVER BASIN
(KANSAS PORTION)
RIVER BASIN STUDY
USDA SCS
2-12-71
5,S-28,541.11

EXHIBIT NO. 6

Arkansas River Basin -Kansas
Exhibit 7 - Maximum Recorded Flood Peaks and Dates
Compared to Probable 100 Year Flood

Stream and Station	Total Drainage Area (sq.mi.)	Period of Record	Maximum Discharge: Discharge (cfs)	Maximum Discharge: Date	Probable 100 Year Frequency Discharge (cfs) 1/
Upper Arkansas Unit					
Pawnee River near Larned	2,148	1924-1968	16,300	July 1958	21,000
Walnut Creek near Albert	1,410	1958-1968	12,700	September 1959	22,000
Lower Arkansas Unit					
Cow Creek near Lyons	728	1938-1968	12,400	October 1941	25,000
Little Arkansas River at Valley Center	1,327	1922-1968	32,000	April 1945	46,200
S. Fork Ninnescah River near Murdock	650	1950-1968	25,900	June 1957	28,500
Ninnescah River near Peck	2,129	1938-1968	38,200	May 1957	44,200
Medicine Lodge River near Kiowa	903	1938-1950 1954-1955 1959-1968	16,000	October 1941	59,600
Chikaskia River near Corbin	794	1951-1965	38,100	May 1957	49,000

1/ Soil Conservation Service estimates

Arkansas River Basin-Kansas

Exhibit 7 - Maximum Recorded Flood Peaks and Dates Compared to Probable 100 Year Flood

Stream and Station	Total Drainage Area (sq.mi.)	Period of Record	Maximum Discharge: Discharge (cfs)	Maximum Discharge: Date	Probable 100 Year Frequency Discharge (cfs)[1/]
Walnut-Verdigris Unit					
Cole Creek near DeGraff	30	1961-1968	11,100	June 1965	12,600
Whitewater River at Towanda	426	1961-1968	40,200	June 1965	97,100
Timber Creek near Wilmot	63	1962-1968	6,170	November 1964	22,000
Verdigris River near Madison	181	1955-1968	34,700[2/]	July 1958	49,000
Fall River near Eureka	307	1946-1968	91,800	June 1951	84,300
Otter Creek at Climax	129	1946-1968	44,000	September 1961	45,800
Fall River near Fall River	585	1939-1968	45,600	April 1945	79,000
Fall River at Fredonia	827	1938-1968	49,000	April 1945	71,000
Elk River at Elk Falls	220	1967-1968	7,240	July 1967	49,000
Elk River at Elk City	575	1938-1968	100,000	May 1961	101,700
Big Hill Creek near Cherryvale	37	1957-1968	5,030	July 1967	8,700
Caney River near Elgin	445	1938-1968	62,000	September 1961	62,100

1/ Soil Conservation Service estimates
2/ Estimated July 1951 flood peak 128,000 cfs

Arkansas River Basin-Kansas

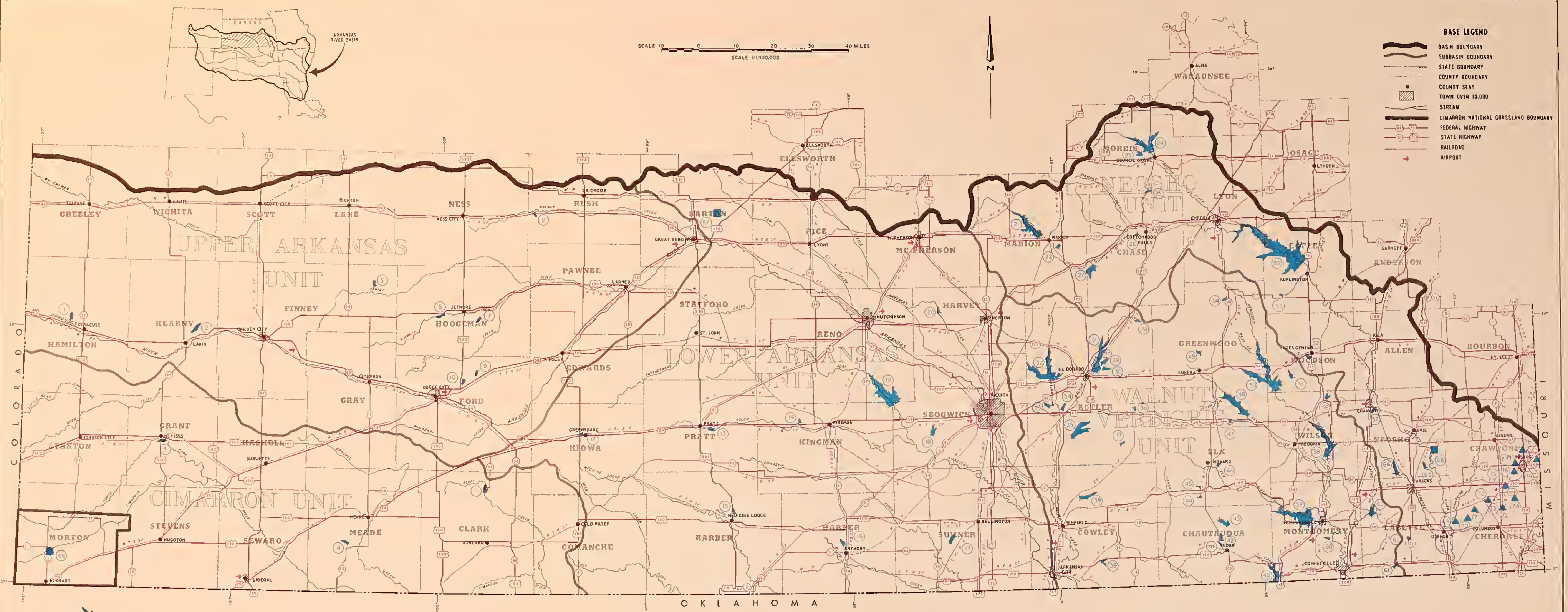
Exhibit 7 - Maximum Recorded Flood Peaks and Dates Compared to Probable 100 Year flood

Stream and Station	Total Drainage Area (sq.mi.)	Period of Record	Maximum Discharge: Discharge (cfs)	Maximum Discharge: Date	Probable 100 Year Frequency Discharge (cfs)1/
<u>Neosho Unit</u>					
Neosho River at Council Grove	250	1938-1968 2/	121,000	July 1951	77,500
Four Mile Creek near Council Grove	55	1963-1968	5,680	June 1967	17,600
Cottonwood River near Marion	329	1938-1968 3/	66,000	July 1951	55,000
Cedar Creek near Cedar Point	110	1938-1968	52,400	June 1951	47,300
Owl Creek near Piqua	177	1959-1968	22,000	September 1961	35,400
Lightning Creek near McCune	197	1938-1946 1959-1968	23,000	May 1943	27,580

1/ Soil Conservation Service estimates
2/ Flow regulated by Council Grove Reservoir since October 1964
3/ Flow regulated by Marion Reservoir since February 1968. Gage discontinued September 1968

U S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



LAKE OR RESERVOIR

1. Hamilton Co. State Lake
2. Lake McKinney
3. Ulysses City Lake
4. Meade Co. State Lake
5. Finney Co. State Lake
6. Hodgeman Co. Lake
7. Hodgeman Co. State Lake
8. Rush Co. State Lake
9. Nains Lake - Co. Lake
10. Ford Co. Lake
11. Clark Co. State Lake
12. Kiowa Co. State Lake
13. Pratt Co. State Lake
14. Kingman Co. State Lake
15. Barber Co. State Lake
16. Anthony City Lake
17. Wellington City Lake
18. Lake Afton - Co. Lake
19. Cheney Reservoir - Bureau of Reclamation
20. Narvey Co. Lake
21. Marion Reservoir - Corps of Engineers
22. Marion Co. Lake
23. Council Grove City Lake
24. Council Grove Reservoir - Corps of Engineers
25. Kahola - City Lake
26. Chase Co. State Lake
27. Cedar Point Reservoir - C of E, Authorized, Not Built
28. Cassoday Lake - City Lake
29. Lake Eldorado - City Lake
30. Lake Bluestem - City Lake
31. Eldorado Reservoir - C of E, Authorized, Not Built
32. Towanda Reservoir - C of E, Authorized, Not Built
33. Butler Co. State Lake No. 1
34. Augusta City Lake
35. Douglas Reservoir - C of E, Authorized, Not Built
36. Lake Woody - Girl Scout Lake
37. Butler Co. State Lake No. 2
38. Winfield City Lake
39. Cowley Co. State Lake
40. Copan Reservoir - C of E, Authorized, Not Built
41. Deer Creek Lake - City
42. Sedan Lake - City
43. Murray Gill Lake - Boy Scout Lake
44. Moline Lake - City
45. Moline Lake - City
46. Noward Lake - City
47. Severy Lake - City
48. Fall River Reservoir - Corps of Engineers
49. Eureka Lake - City
50. Toronto Reservoir - Corps of Engineers
51. Woodson Co. State Lake
52. Yates Center Lake - City
53. Gridley Lake - City
54. Madison City Lake
55. John Redmond Reservoir - Corps of Engineers
56. Wilson Co. State Lake
57. Chanute Lake - City
58. Neodesha Reservoir - C of E, Authorized, Not Built
59. Elk City Reservoir - Corps of Engineers
60. Montgomery Co. State Lake
61. Edna Lake - City
62. Altamont Lake - City
63. Big Nill Reservoir - C of E, Authorized, Not Built
64. Parsons Lake - City
65. Neosho Co. State Lake

WATERFOWL MANAGEMENT AREA

66. Cimarron National Grasslands
67. Cheyenne Bottoms
68. Neosho

STRIP PIT RECREATION AREA

69. Forestry Fish and Game Commission
70. Forestry Fish and Game Commission
71. Forestry Fish and Game Commission
72. Forestry Fish and Game Commission
73. Forestry Fish and Game Commission
74. Forestry Fish and Game Commission
75. Forestry Fish and Game Commission
76. Forestry Fish and Game Commission
77. Forestry Fish and Game Commission
78. Forestry Fish and Game Commission
79. Forestry Fish and Game Commission

WATER BASED RECREATION AREAS AND TRANSPORTATION FACILITIES

ARKANSAS RIVER BASIN

(KANSAS PORTION)

RIVER BASIN STUDY

USDA SCS

SOURCE
USGS 1/500,000 BASE MAP AND
INFORMATION FROM FIELD

LAMBERT CONFORMAL CONIC PROJECTION

REV 10-25-72
5,S-28,541.6

EXHIBIT NO 8

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1/])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Upper Arkansas Unit							
Finney County State Lake	Forestry, Fish & Game Commission	530	324	Largemouth Bass Channel Catfish Bluegill Fathead Minnows Black Crappie	42[2/]	50 (Fair)	Insufficient rainfall and upstream storage ponds have limited inflow. On Jan., 1969, the lake area was 40 acres. The lake was stocked in 1967 and opened to fishing in Oct., 1968.
Ford County Lake	County	234	65	Largemouth Bass Channel Catfish Black Bullhead Black & White Crappie Bluegill Carp	215	85 (Fair)	The lake receives heavy use from Dodge City. Its main problems are maintaining a normal pool area of 65 surface acres, sedimentation and marginal water turbidity.
Haines Lake (Ford County)	Forestry, Fish & Game Commission	333	53	Largemouth Bass Channel Catfish Bluegill Black Bullhead Black & White Crappie Carp	75	35 (Fair)	The lake was built in 1936 and controlled by private individuals until 1969 when it was taken over by the Forestry, Fish & Game Commission. It has a minor problem with turbidity and a decreasing water level during dry months and drought years.
Hamilton County State Lake	Forestry, Fish & Game Commission	338	94	Largemouth Bass Channel Catfish Bluegill	65[3/] 100[4/]	20[3/] 100[4/] (good)	The lake has the potential for excellent fishing quality. The water is clear, of good quality and remains at a fairly stable level. The lake was rehabilitated in 1969 and will not be open until 1971. In addition to the normal species, walleye fingerlings were released into the lake in June, 1970.
Hodgeman County State Lake	Forestry, Fish & Game Commission	167	87	--	--	--	The lake is dry.
Kearny County State Lake (Lake McKinney)	Forestry, Fish & Game Commission	Not Known	3,000	Largemouth Bass White Bass Black Crappie Bluegill Carp Carpsucker Channel Catfish	7	6 (Fair)	The lake is managed primarily for irrigation purposes. The pool level fluctuates and it has moderately high turbidity. Game species--largemouth bass, white bass, and panfish--have limited or no annual reproduction. It has a heavy population of rough fish.
Lane County State Lake	Forestry, Fish & Game Commission	Not Known	21	Largemouth Bass Bluegill Channel Catfish	(Not known--new lake)		

See footnotes on page 13 of 18

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre 1/)	Fisherman Success & Rating (Lbs./Acre)	Remarks
Upper Arkansas Unit, continued							
Scott County Lake	Park & Resources Authority	1,005	115	Largemouth Bass Channel Catfish Black & White Crappie Drum Black Bullhead Carp	100	50 (Fair)	The lake is one of the oldest in the state. It is badly silted and generally remains turbid despite constant inflow from springs. The turbidity is caused by large numbers of carp and wind action which keeps the silt stirred up and in suspension.
Cimarron Unit							
Clark County State Lake	Forestry, Fish & Game Commission	906	337	Northern Pike Largemouth Bass Bluegill Black & Yellow Bullhead Channel Catfish Black & White Crappie	60	75 (Excellent)	The lake is an excellent fishing lake because some species of fish can be caught almost any time pressure is applied. It is particularly good for channel catfish. Generally, the water remains clear, resulting in vegetation and panfish control problems. Northern pike were recently introduced to aid in the control of the panfish population.
Cimarron Wildlife (Morton County)	Forestry, Fish & Game Commission	523	27	Largemouth Bass Channel Catfish Bluegill Green Sunfish	50	25 (Fair)	The lakes are dug ponds adjacent to the Cimarron River. They are small with clear water and receive heavy fishing pressure from the local population. Due to their shallow and clear water characteristics, they tend to become chocked with aquatic vegetation during the summer.
Meade County State Lake	Forestry, Fish & Game Commission & Park & Resources Authority	310	100	Largemouth Bass Channel Catfish Bluegill Green Sunfish Northern Pike	120	50 (Good)	The area around the lake is managed by the Park & Resources Authority with facilities for picnicking, camping, and swimming. It receives heavy use during the summer months. The shallow water in the upper end is heavily congested with vegetation, primarily pond weeds. The majority of the vegetation is restricted to water less than 7 feet in depth.
Miller-Clarkson Lake (Clark County) 10S-4W Minneola	Private	Not Known	180	Channel Catfish Largemouth Bass Bluegill	15	10 (Excellent)	The lake provides excellent fishing for club members. It was rehabilitated and stocked in 1965.
Ulysses City Lake	City	180	44	--	--	--	The lake generally remains dry or has insufficient water to provide a significant amount of fishing. It is relatively shallow and moderately turbid. The Forestry, Fish & Game Commission stocked channel catfish fingerlings in the spring of 1969.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Lower Arkansas Unit							
Anthony City Lake (Harper County)	City	400	160	Channel Catfish Largemouth Bass Crappie Bullhead	125	50 (Fair)	The lake has a turbidity problem which has limited its productivity.
Barber County State Lake	Forestry, Fish & Game Commission	113	Upper 26 Lower 51	Largemouth Bass Bluegill Channel Catfish Black Bullhead	150[6]	100[6] (Good)	Storage structures above the lake reduced its inflows so that the desired water level could not be maintained. It was divided by a dike into a 26-acre upper lake and a 51-acre lower lake. The water level in the lower lake is maintained by pumping from two wells. The lower lake was stocked in 1968 and opened for fishing in 1970. The upper lake is also full and opened for fishing.
Brandy Lake (Reno County) Approx. 6 miles east of Hutchinson on U.S. 50	Private	Not Known	55	Bullhead Channel Catfish Crappie Largemouth Bass Carp	50	40 (Fair)	The lake was formed from a depression and borrow area along highway U.S. 50. Water is pumped to keep it full. It is heavily populated with rough fish and panfish.
Cheney Reservoir (Kingman, Reno, and Sedgwick Counties)	Bureau of Reclamation & City of Wichita	4,563	9,500	Black & White Crappie White Bass Walleye Channel Catfish Black & Yellow Bullhead Drum Largemouth Bass Bluegill Bigmouth & Smallmouth Buffalo Carp	15	22 (Good to Excellent)	The lake is in excellent condition and should offer excellent fishing.
Cheyenne Bottoms Waterfowl Management Unit (Barton County)	Forestry, Fish & Game Commission	19,600	12,290	Channel Catfish Bullhead Carp	1.5	1.5 (Good)	Fishing is restricted to certain areas and is prohibited during a portion of the year at this waterfowl area.
Deselms Lake (Stafford County)	Private	210	40	Channel Catfish Bluegill Largemouth Bass Crappie Drum Carp	25	15 (Fair)	The lake is generally turbid, badly silted, and has an over-population of rough fish. The main use is for water storage.

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Lower Arkansas Unit, continued							
Harvey County Lake	County	250	40	Largemouth Bass Channel Catfish Bullheads Crappies Carp Carpsucker Drum Shad	200[7] 130[8]	200[7] 70[8] (Fair to Poor)	The lake presently needs rehabilitation but the controlling authority does not want the lake out of use for the time required. The fish population is now being supplemented by stocking with short channel catfish.
Lake Inman (McPherson County)	Private	Not Known	185	Channel Catfish Black Bullhead Bluegill Black Crappie Green Sunfish Carp Buffalo	Limited	Limited	The lake is said to be the only "natural" lake in Kansas. It is generally shallow, turbid, heavily silted and receives limited angler use.
Kingman County State Lake	Forestry, Fish & Game Commission	1,377	185	Largemouth Bass Channel Catfish Bluegill Walleye Black & Yellow Bullhead	100	50 (Good)	The lake requires periodic rehabilitation because of rough fish which move in from the drainage area and overpopulate the lake. It was last rehabilitated and stocked in 1967 and reopened to public fishing in 1969.
Kiowa County State Lake	Forestry, Fish & Game Commission	Not Known	21	Largemouth Bass Black Crappie Channel Catfish Black Bullhead Bluegill	225	120 (Fair)	The lake is new and was first opened to fishing during the spring of 1969.
Paradise Isles Lake (Reno County) 1W-2 ½ South of Burrton, Ks.	Private	120	40	Channel Catfish Largemouth Bass Bluegill Green Sunfish Crappies Carp	50	30 (Fair)	The lake is an old sand pit. It is very deep and infertile. It has a heavy population of rough fish and panfish.
Pratt County Lake	County	Not Known	90	Channel Catfish Crappies Largemouth Bass Bluegill Carp	60	30 (Fair)	The lake receives heavy use for water sports and tends to remain turbid over much of the year. The water level is maintained by pumping ground water into the lake. It needs to be rehabilitated. The majority of the fishing occurs in the river above the lake and below the dam.
Private Areas (26 small lakes)(Sedgwick County)	Private	Not Known	1,030 Total (Each has 15 acres or more)	Largemouth Bass Channel Catfish Crappie Green Sunfish Black Bullhead Bluegill Carp	20	5 (Fair)	Many of the lakes are old sand pits. Some of them are not heavily fished and therefore the use and productivity are low.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimate Fisherman Use (Man Days/Acre[1/])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Lower Arkansas Unit, continued							
Private Areas (Harvey County)	Private	105 Total	120 Total	These areas are mostly sand pits of similar nature to those in the Sedgwick County sand pits listed above	Not Known	Not Known	The lakes are old sand pits and are generally over-populated with panfish. Most are not heavily fished and therefore the use and productivity are low.
Quivira Wildlife Refuge (Stafford County)	U.S. Bureau of Sport Fisheries & Wildlife	15,795	6,205	Channel Catfish Black Bullhead Crappie Carp Bluegill Green Sunfish	--	--	Fishing is restricted to certain areas and is prohibited during a portion of the year at this waterfowl area.
Sedgwick County Lake (Lake Afton)	County	552	238	Carp Channel Catfish Largemouth Bass Black Bullhead Black & White Crappie Bluegill Drum Flathead	150	45 (Fair)	The lake receives heavy use for water sports and tends to remain turbid over much of the year. It is over-populated with slow growing panfish and rough fish.
Watson Park Lakes (Sedgwick County)	City of Wichita	79	40	Largemouth Bass Channel Catfish Black & White Crappie Bluegill Black Bullhead Carp	75	20 (Fair)	The lakes are old sand pits and are generally over-populated with panfish. Most are not heavily fished and therefore the use and productivity are low.
Wellington City Lake (Sumner County)	City	432	390	Largemouth Bass Channel Catfish Crappie Green Sunfish Bullhead Carp	90	35 (Fair)	The lake has a turbidity and silt problem. It is heavily populated with rough fish.
Wellington City Park Lake (Sumner County)	City	Not Known	Not Known	White Crappie Carp Green Sunfish Bluegill Shad Carpsucker Channel Catfish Buffalo Gar Largemouth Bass	Not Known	Not Known	The impoundment is open to the public and contains a large variety of game and panfish species.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre 1/)	Fisherman Success & Rating (Lbs./Acre)	Remarks
Walnut-Verdigris Unit							
Augusta City Lake (Butler County)	City	88	182	Largemouth Bass Channel Catfish Flatheads Bullheads Crappies Carp Drum Bluegill & Sunfish	100	20 (Poor)	The water is extremely turbid and the watershed is in bad condition. Rehabilitation is impractical by normal reclamation methods. The lake is primarily for water supply and cannot be managed for maximum fishery production.
Augusta City Lake on Elm Creek (Butler County)	City	121	284	Largemouth Bass Channel Catfish Bullheads Bluegill & Sunfish Crappies Carp	60	50 (Fair)	The lake has periods of high turbidity. The rough fish population is apparently stabilized at low levels. Channel catfish recruitment is suspected. It has occasional crappie runs. The lake is primarily for water supply and cannot be managed for maximum fishery production.
Lake Bluestem (Butler County)	City of El Dorado	1,735	845	Largemouth Bass Channel Catfish Crappies Bullhead Carp Drum Shad Carpsucker Redhorse	20	5 (Poor)	The lake has excessive turbidity. The rough fish population is dominant. It is primarily for water supply and cannot be managed for maximum fishery production. It may be made a subimpoundment upon creation of the proposed El Dorado Reservoir. Or it may be lowered 4 feet and become part of the reservoir.
Boy Scout Lake (Chautauqua County)	Boy Scouts of America--Wichita Council	1,428	472	Largemouth Bass Spotted Bass White Bass Channel, Bullhead Bluegill & Sunfish Carp Redhorse Black & White Crappie Shad	200 7/ 100 8/	150 7/ 100 8/ (Excellent)	This is a new lake. Rough fish have already gained a strong foothold but their numbers will stabilize as the lake matures. Fishing pressure is limited because use is restricted to Boy Scouts and maximum productivity is not obtained.
Clymer State Lake (Butler County)	Forestry, Fish & Game Commission	227	124	Largemouth Bass Channel Catfish Black Bullhead Bluegill & Sunfish Black & White Crappie Carp Shad	200 7/ 100 8/	150 7/ 50 8/ (Good)	Due to excessive shallow water and associated wave action--rolling, turbid water has fostered an expanding rough fish population. Channel and panfish growth is retarded. Improved water conditions and rough fish control would increase lake utilization and harvest. Water conditions improved during 1968 and success went to 180+lb./acre.
Cassoday Lake (Fox Lake) (Butler County)	Township Lake leased to a private club		120	Largemouth Bass Black & White Crappie Bluegill Bullhead Carp, Drum & Buffalo	Unknown		Rehabilitated in 1955. Surveyed in 1969. Found dominant rough fish population. Problems include turbidity and excessive vegetation.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1/])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Walnut-Verdigris Unit, continued							
Cowley County State Lake	Forestry, Fish & Game Commission	117	80	Largemouth Bass Smallmouth Bass Bluegill & Sunfish Bullheads Crappies Channel Catfish	150	100 (Good)	The lake is a consistently good producer of largemouth bass and channel catfish. Supplemental stocking of channel catfish is necessary to maintain this fishery. Panfish are acceptable but are not utilized to fullest extent.
El Dorado City Lake (Butler County)	City	121	284	Largemouth Bass Channel Catfish Crappies (White) Bluegill & Sunfish Bullhead Carp Carpsucker Drum Shad	30	50 (Fair to Poor)	The lake is heavily silted in the upper basin. It remains turbid. The lake is primarily for water supply and cannot be managed for maximum fishery production. The proposed El Dorado Reservoir will inundate this impoundment.
Elk City Reservoir (Montgomery County)	Corps of Engineers	16,650	3,550	Largemouth Bass Channel Catfish White Bass Flathead Walleye Northern Pike Bluegill & Sunfish Carp Carpsucker Drum Bullhead Buffalo Shad Gar Crappies	10	8 (Good)	Rough fish dominate the fish population of the reservoir. Large shallow areas and wind action produce turbidity which restricts the game fish productivity. The future of northern pike in the lake is questionable.
Eureka City Lake (Greenwood County)	City	500	259	Largemouth Bass Spotted Bass Channel Catfish Bullhead Flathead Bluegill & Sunfish Rough Fishes	75	60 (Fair)	Up-to-date lake conditions are not known. The lake is primarily for water supply and cannot be managed for maximum fishery production.

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1/])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Walnut-Verdigris Unit, continued							
Fall River Reservoir (Greenwood County)	Corps of Engineers	10,000	2,600	Largemouth Bass Spotted Bass White Bass Channel Catfish Flathead Catfish Bullheads Bluegill & Sunfish Gar Crappies Drum Carpsucker Walleye Redhorse Shad Bigmouth, Smallmouth & Black Buffalo	15	8 (Fair)	Recent upstream watershed structure development appears to be reducing extended periods of high turbidity. If the clearing trend continues, a slight shift in the present fish population may occur to the favor of game species. Rough fish now dominate. Such a shift would improve the crappie harvest for a short period and the walleye harvest for a longer period.
Howard City Lake (Elk County)	City	85	68	Largemouth Bass Spotted Bass Channel Catfish Bullheads Bluegill & Sunfish Crappies Carp	125	50 (Fair)	Panfishes are severely stunted. Supplemental stockings of channel catfish grow slowly but are acceptable. The rough fish population is stabilized. Rehabilitation is advisable but not practical since the lake is a city water supply.
Madison City Lake (Greenwood County)	City	Not Known	104	New Lake	--	--	The lake was stocked with fish in the fall of 1970 and will provide excellent fishing opportunity in approximately 2 years.
Moline City Lake (Elk County)	City	12	28	Largemouth Bass Channel Catfish Bullheads Bluegill & Sunfish Crappies	80	50 (Fair)	The lake is primarily for water supply and cannot be managed for maximum fishery production. It has received periodic stockings of intermediate sized channel catfish.
Montgomery County State Lake	Forestry, Fish & Game Commission	303	105	Largemouth Bass Channel Catfish Bluegill & Sunfish Crappies Bullheads Carp	200	150 (Good)	The lake has a submerged aquatic vegetation problem and a stabilized rough fish population. Supplemental stocking of channel catfish in clear water keep the productivity of the lake high.
Sedan City Lake (Chautauqua County)	City	260	55	Largemouth Bass Channel Catfish Flathead Bullhead Bluegill & Sunfish Black & White Crappies Drum Spotted Bass	50	30 (Fair)	The fishery is suspected of being similar to that at Howard City Lake, but without rough fish. The lake is primarily for water supply and cannot be managed for maximum fishery production.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1/])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Walnut-Verdigris Unit, continued							
Sedan City Lake (New) (Chautauqua County)	City	388	75	Largemouth Bass Spotted Bass Channel Catfish Bullhead Bluegill & Sunfish Crappies	100	130 (Good to Excellent)	The lake is new and has a developing fish population.
Severy City Lake (Greenwood County)	City	60	20	Largemouth Bass Channel Catfish Bluegill & Sunfish Bullheads Crappies	50	25 (Fair to Poor)	Up-to-date conditions are not known. The lake is primarily for water supply and cannot be managed for maximum fishery production.
Toronto Reservoir (Woodson County)	Corps of Engineers	5,941	2,800	Largemouth Bass White Bass Bluegill & Sunfish Flathead Channel Catfish Crappie Bullheads Carp Carpsucker Shad	8	5 (Fair)	The reservoir has excessive turbidity which as yet has not been reduced by recent watershed structure development upstream. Efficient predator species are lacking and crappie growth is retarded. Catfish and sometimes white bass are the major species sought.
Wilson County State Lake	Forestry, Fish & Game Commission	172	119	Largemouth Bass Channel Catfish Bluegill & Sunfish Crappie Bullheads Carp Carpsucker Shad	125	90 (Good to Fair)	The lake has a developing rough fish population which is retarding the growth of panfish. Supplemental stocking of channel catfish is necessary.
Winfield City Lake (Cowley County)	City	Not Known	1,130	New Lake	--	--	The lake was stocked with fish in the fall of 1970 and will provide excellent fishing opportunity in approximately 2 years.
Woodson County State Lake	Forestry, Fish & Game Commission	266	179	Largemouth Bass Channel Catfish Bluegill & Sunfish Crappie Bullhead Carp Shad	100	100 (Fair to Good)	The lake has a slowly developing rough fish population. Submerged aquatic vegetation is a problem in marginal areas of the lake. Supplemental stockings of channel catfish help to maintain good fishing in the lake.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Neosho Unit							
Bartlett City Lake (Labette County)	City	12	21	Largemouth Bass Channel Catfish Bullheads Bluegill Other Sunfishes Rough fish and Crappie	50	25 (Fair)	The present conditions are unknown.
Baxter Spring City Lake (Cherokee County)	City	42	70	Largemouth Bass White Bass Channel Catfish Flathead Bullheads Sunfishes Carp Shad Gar Carpsucker Drum Buffalo	50	10 (Poor to Fair)	The lake is created by a low-water dam in the Spring River channel. It reduces the riffle area and increases the depth of pools of the Spring River. Conditions vary considerably depending upon stream flow.
Chase County State Lake	Forestry, Fish & Game Commission	383	109	Largemouth Bass Channel Catfish Bluegill & Sunfish Bullheads White Bass Shad Crappie Carp	200[7] 75[8]	180[7] 50[8] (Fair to Good)	The fishery is approaching over-crowded conditions due to selective fishing and expanding rough fish populations. Utilization is low. White bass and largemouth bass are in good condition. Channel catfish are growing slowly.
Council Grove City Lake (Morris County)	City	725	434	Largemouth Bass Walleye Channel Catfish Flatheads Bluegill & Sunfish Crappie Rough Fishes	150	80 (Fair to Good)	The lake is clear and control of submerged aquatic vegetation is a problem. Walleye have grown well and recruitment is suspected.
Council Grove Reservoir (Morris County)	Corps of Engineers	3,490	2,860	Largemouth Bass Channel Catfish Flathead Walleye Northern Pike Bluegill & Sunfish Crappies Carp Carpsucker Buffalo Shad	20	8 (Fair to Good)	Rough fish are numerous in the lake and it has extended periods of high turbidity. The catfish is prosperous and provides a majority of the fishing success in the reservoir. The record northern pike caught in Kansas--18 pounds, 5 ounces--was taken from Council Grove Reservoir in 1969. However, the future of the northern pike population is questionable.

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1/])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Neosho Unit, continued							
Emporia Lake (Cherokee County)	Empire Electric Company (Private)	Not Known	860	Largemouth Bass Spotted Bass Channel Catfish Flathead Catfish Bluegill & Sunfish Crappie Shad Buffalo Carp Carpsucker Drum Gar	50	Not Known	The lake impounds the waters of Spring River and Shoal Creek. The large variety of fish at present receive moderate angler utilization.
Emporia City Lake (Lake Kahola) (Chase & Morris Counties)	City	400	400	Largemouth Bass Channel Catfish Bullheads Crappie Bluegill & Sunfish	75	80 (Fair to Good)	Lake rehabilitated during late 1950's. City maintains channel catfish rearing ponds and annually stocks channel catfish.
Gridley City Lake (Coffey County)	City	42	25	Largemouth Bass Channel Catfish Bluegill Bullheads Crappie Sunfish	50	40 (Fair)	The lake is clear and control of submerged aquatic vegetation is a problem.
John Redmond Reservoir (Coffey County)	Corps of Engineers	24,680	7,780	White Bass Flathead Channel Catfish Bullheads Largemouth Bass Walleye Carp Carpsucker Buffalo Long & Short Nose Gar Shad Drum Crappie Bluegill	10	8 (Fair to Good)	The reservoir has a shallow mean depth and many mud flats which result in high turbidity. Good populations of catfish are present but the turbidity has restricted the development of scaled game species. The reservoir has one of the highest crops of catfish and rough fish in the country.
Kansas Gas & Electric Lake (Labette County)	Kansas Gas & Electric (Private)	60	140	Largemouth Bass Channel Catfish Flathead Catfish Bullheads Bluegill & Sunfish Carp Shad	30	20 (Fair)	Channel catfish have been reared by the power company from time to time and released into the impoundment. The condition of the fish population is unknown.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre[1])	Fisherman Success & Rating (Lbs./Acre)	Remarks
Neosho Unit, continued							
Marion County Lake	County	147	153	Largemouth Bass Channel Catfish Flathead Bullhead Walleye Bluegill & Sunfish Carp Shad Crappie	150	80 (Fair to Good)	The lake has been supplementally stocked with walleye and channel catfish. Seasonal sectional and shoreline applications of fish toxicant are being made to retard panfish expansion. Northern pike may be introduced in the future.
Marion Reservoir (Marion County)	Corps of Engineers	12,630	6,160	Largemouth Bass Channel Catfish Flathead Catfish Bluegill & Sunfish Bullhead Crappie Shad Walleye Northern Pike	15[7]	10[7] (Good)	The reservoir was filled for the first time in the spring of 1969. Fishing is developing to the usual good quality which is expected for the first few years after a new reservoir fills.
Neosho County State Lake	Forestry, Fish & Game Commission	124	92	Largemouth Bass Bluegill & Sunfish Crappie Channel Catfish Bullhead	230[7] 150[8]	250[7] 130[8] (Good to Excellent)	The lake is clear and control of submerged aquatic vegetation is a problem. Supplemental stocking of channel catfish is necessary.
Neosho Waterfowl Refuge Area (Neosho County)	Forestry, Fish & Game Commission	1,306	800	Largemouth Bass Channel Catfish Bluegill & Sunfish Crappie Carp Carpsucker Buffalo 3 species of Gar Bullhead Shad	30	15 (Fair to Poor)	A portion of this area is very shallow and subject to high turbidity. It has an extremely high rough fish population. An occasional crappie run does occur.
Parson City Lake (Neosho County)	City	1,200	1,000	Largemouth Bass Channel Catfish Flathead Bluegill Other Sunfish Crappie Bullhead Carp Carpsucker Buffalo Gar Shad	30	15 (Fair to Good)	The lake provides anglers with a periodic crappie run and good fishing of catfish. As in most waters of southeastern Kansas, lunker large mouth bass are present.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Lake Fisheries

Impoundment Name & County Location	Managing Agency	Acreage Land	Acreage Water	Significant Species Present	Estimated Fisherman Use (Man Days/Acre 1/)	Fisherman Success & Rating (Lbs./Acre)	Remarks
Neosho Unit, continued							
Strip Pits (Crawford & Cherokee Counties)	Forestry, Fish & Game Commission	6,400	530	Largemouth Bass Channel Catfish Bluegill & Other Sunfish Bullhead Crappie Carp	200 7/ 150 8/	150 7/ 50 8/ (Fair to Excellent)	There are approximately 120 surface acres in Crawford County and 410 surface acres in Cherokee County. These are part of approximately 6,400 acres of stripmine land which the Forestry, Fish & Game Commission controls. The 530 acres of water are divided into many stripmine ponds, 1 acre or larger in size. It is estimated that 20 percent of the total water area is acid water not suited to fisheries. Under a rather intensive fishery management program, 7 of the strip land lakes have developed into excellent fishing waters.
Thayer City Lake (Neosho County)	City	Not Known	25	Largemouth Bass Channel Catfish Bluegill Other Sunfish Black Crappie Bullhead	30	20 (Fair)	The water is extremely clear with most of the lake containing submerged aquatic vegetation.
Yates Center City Lake (Woodson County)	City	200	120	Largemouth Bass Bluegill & Sunfish Channel Catfish Flathead Bullhead Carp Drum Shad	30	15 (Poor)	The lake needs rehabilitation but is a municipal water supply.

1/ A Man Day is defined as a fishing activity for any length of time in any one day.

2/ Based on the more typical surface area of 60 acres.

3/ Productivity low and not typical.

4/ Rating after rehabilitation.

5/ Estimated use and productivity.

6/ Expected normal production.

7/ Potential production.

8/ Current condition.

Stream	Fish Species Dominating the Population 1/	Remarks 2/
Upper Arkansas Unit		
Arkansas River	Carp Carpsucker Channel Catfish Flathead Bullhead Gar	The river is fished at various points along its course. This fishing pressure increases as the river approaches the metropolitan areas. The flow has considerable variation which can be attributed largely to upstream irrigation diversions. Angling success can best be described as fair throughout the year. Access cannot be described as good, but much of the river is accessible to those fishermen who seek and secure permission of the adjacent landowners. Feedlot pollution potential is increasing yearly along this river.
Pawnee River	Carp Channel Catfish Bullhead	The river is subject to low flow due to irrigation demands. Above and around Larned, Kansas, this river offers good fishing potential. Fishing access is somewhat restricted above Larned, but good access is available in and around Larned, and many people fish there.
Walnut Creek	--	The creek provides a limited amount of fishing opportunity.
Cimarron Unit		
Cimarron River	Carp Channel Catfish Black Bullhead Green Sunfish	The river crosses many large pastures and access is limited to roadways, bridges and railroad crossings. Access in some areas can be obtained by landowner permission. The river is broad and shallow. Fishing is confined to deep holes around impediments in the river.
Lower Arkansas Unit		
Arkansas River	Carp Carpsucker Channel Catfish Flathead Bullhead Gar Shad	The river is fished at various points along its course. This fishing pressure increases as the river approaches the metropolitan areas. The streamflow is seasonal with high flows dependent on storm runoff. Increased water use adjacent to the river has reduced the flowage resulting in extremely low flows during drought periods. Fishing is more or less related to the movement of fish which occurs when the river is up. Following such raises, while the water level is receding, fishermen have relatively good success fishing in the deep holes, behind natural and man-made impediments to the flow and in the mouth of creeks or oxbows.
Bluff Creek Harper County	Green Sunfish Black Bullhead Carp Carpsucker Channel Catfish	The limitations are low stream levels and access, although anglers can usually get permission by contacting landowners.
Chikaskia River	Carp Channel Catfish Bullhead	This river probably offers the best fishing potential in terms of angling return; however, it does not maintain a very substantial flow. It appears the river is fished mostly while it is up.
Cow Creek Rice & Reno Counties	Carp Channel Catfish Flathead	Access is limited along this creek but many fishermen fish off the bridges, road right-of-ways and in daily assessed areas. (25¢ for tresspass rights) While the creek is up and going down, fishing can be described as good. Stream fishing is threatened by the flood-control channelization project being considered by the Corps of Engineers.

See footnotes on page 18 of 18

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Stream Fisheries

Stream	Fish Species Dominating the Population[1]	Remarks[2]
Lower Arkansas Unit, continued		
Cowskin Creek, Wichita Goddard to Haysville	Carp Channel Catfish Flathead	Access is limited in this stream, but fishing is reported good following a raise and reduction in the level of the creek. Many good flathead catfish are reportedly caught in this creek. Pollution is bad in sections of the creek.
Little Arkansas River	River Carpsucker Carp Shad Channel Catfish Flathead Sunfishes	The limitations are access, shallow water, and pollution (oil, municipal, industrial, agricultural). Beaver dams and man-made dams enhance the fishery.
Medicine Lodge River	Carp Channel Catfish Bullhead	The stream is fished at various points, mostly above Medicine Lodge. The river is shallow in many places and tends to maintain a relatively low flow over much of the year. Access along the river is restricted primarily due to limited access roads (much of the river crosses range land and immense pastures).
Ninnescah River, North Fork	Carp Carpsucker Channel Catfish Bullhead	The stream is fished at various points along its course and fishing can be described as fair. Providing fishermen obtain permission, much of the river can be fished, but access to the public is not generally good. (Access limited.)
Ninnescah River, South Fork	Carp Channel Catfish Carpsucker Bullhead Flathead	The stream is fished at various points along its course and fishing can be described as fair. Much of this river is under leased access, but many fishermen gain access from bridges, railroad crossings, and by obtaining permission from the landowners.
Rattlesnake Creek	Carp Channel Catfish Flathead Bullhead	Like the Chikaskia, this river in recent years tends to fluctuate in water level. During periods of drought, sections of the river dry up and several years of flow are necessary to restore the fishing potential. Access is limited as much of the adjacent land is under lease; however, access can be obtained along some road right-of-ways and by asking permission
Sandy Creek Harper County	Green Sunfish Bullhead Carp Channel Catfish	The limitations are shallow depth, lack of good pools, shifting sand bottom, low water levels, and access.
Slate Creek	Green Sunfish Black Bullhead Carp Channel Catfish	The limitations are a small natural stream below Wellington and low stream levels. The lower section receives drainage from salt marshes in the Geuda Springs area.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Stream Fisheries

Stream	Fish Species Dominating the Population[1/]	Remarks[2/]
Walnut-Verdigris Unit		
Caney Creek Eastern Chautauqua County	Carpsucker Buffalo Carp Shad Spotted Bass Channel Catfish Gar	A large portion of stream is within ranching country where restricted access is common. The stream's fishery attracts local interest only.
Caney River Western Chautauqua County	Carpsucker Buffalo Carp Shad Channel Catfish Spotted Bass Largemouth Bass Gar	A large portion of stream is within ranching country where restricted access is common. The stream's fishery attracts local interests only.
Elk River	Carpsucker Carp Buffalo Shad Drum Channel Catfish Flathead Gar	The entire stream is subject to droughty periods of low flow. The Elk City Reservoir has made possible the successful introduction of walleye into the stream system; however, the extent of future development of this segment of the sport fishery is uncertain.
Fall River	Carpsucker Buffalo Carp Shad Drum Channel Catfish Flathead White Bass Spotted Bass	Upper reaches of the stream in ranching country are characterized by restricted access. The lower reaches are influenced by fluctuations in Fall River Reservoir discharge.
Grouse Creek	Spotted Bass Shad Redhorse Channel Catfish River Carpsucker Flathead Carp Largemouth Bass Sunfishes	The limitations are access and pollution (agricultural) in some localized areas. Enhancing features are man-made dams and clear, fast waters.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Stream Fisheries

Stream	Fish Species Dominating the Population[1/]	Remarks[2/]
Walnut-Verdigris Unit, continued		
Verdigris River	Buffalo Carpsucker Carp Shad Channel Catfish Flathead Drum White Bass Spotted Bass	Upper reaches of the stream in ranching country are characterized by restricted fishing access. Also, the stream character is in the process of change resulting from the completion of watershed structures. The lower reaches are influenced by Toronto Reservoir discharge fluctuations.
Walnut River	River Carpsucker Carp Channel Catfish Flathead Shad Sunfishes Redhorse	The limitations are access and pollution (oil, municipal, industrial, agricultural) in specific sections. Man-made dams enhance the fisheries.
Whitewater River	River Carpsucker Shad Carp Flathead Channel Catfish Sunfishes	The limitation are access and pollution (agricultural, municipal, oil field) in specific sections.
Neosho Unit		
Cottonwood River	Carpsucker Channel Catfish Carp Flathead Bullhead Crappie Shad Spotted Bass Sunfishes	Cattle feedlots, rock quarries, and municipal sewage influences the quality of the fishery locally. Poor access in ranch country limits utilization. Low water dams at Cedar Point, Cottonwood Falls and Emporia provide access.
Neosho River	Buffalo Carpsucker Channel Catfish Carp Shad Flathead Drum White Bass	The fishery of the stream between Council Grove and John Redmond reservoirs is influenced by controlled low flows. Periodic cattle feedlot pollution reduces the fishery quality above John Redmond Reservoir. The lower river (below John Redmond) is heavily fished, but it is greatly influenced by the water release rates of John Redmond Reservoir.

Arkansas River Basin - Kansas
Exhibit 9 - Fisheries Resources
Stream Fisheries

Stream	Fish Species Dominating the Population[1]	Remarks[2]
Neosho Unit, continued		
Shoal Creek above Empire Lake	Largemouth Bass Spotted Bass Channel Catfish Flathead Bluegill & Sunfish Crappie Shad Buffalo Carp Carpsucker Drum Gar	The stream contains the widest variety of fish species found in Kansas. It is Ozarkian in character with cooler water and numerous swift riffles. There is less than five miles of this type of stream in Kansas before it crosses into the Missouri.
Spring River	Buffalo Carpsucker Shad Carp Channel Catfish Crappie Flathead Gar White Bass	The stream receives moderate to heavy utilization. Extent of effect of past mining and industrial pollution upon fishery uncertain.

1/ Species are listed in the order of their suspected abundance.

2/ Access is by far the most limiting factor to a stream being fished.

USDA-SCS-LINCOLN, NEBR. 1972-SR

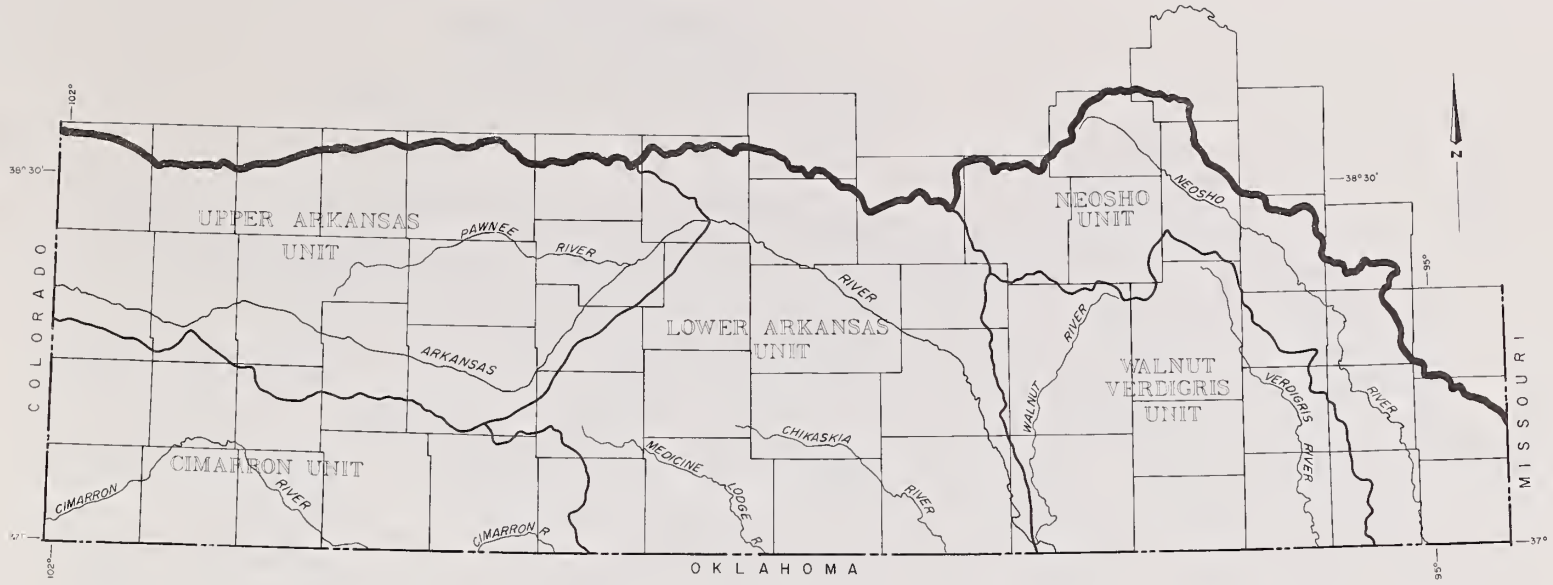
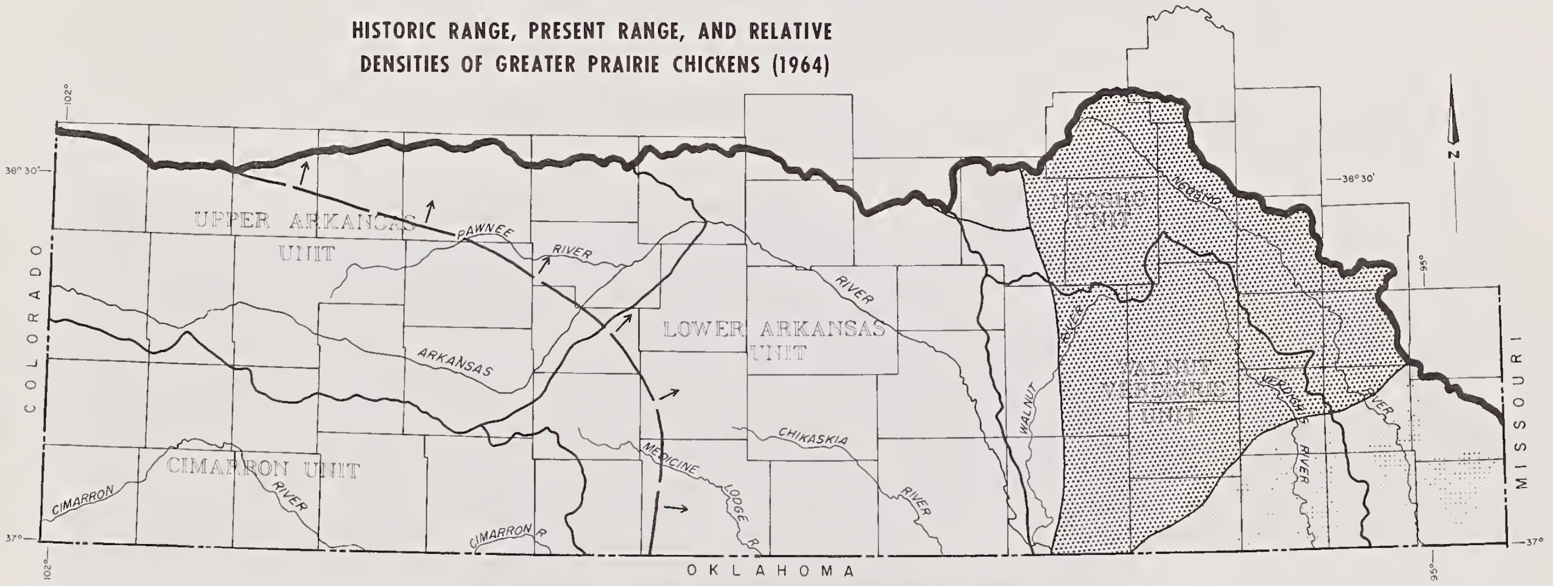


Exhibit 10

WILDLIFE RESOURCES

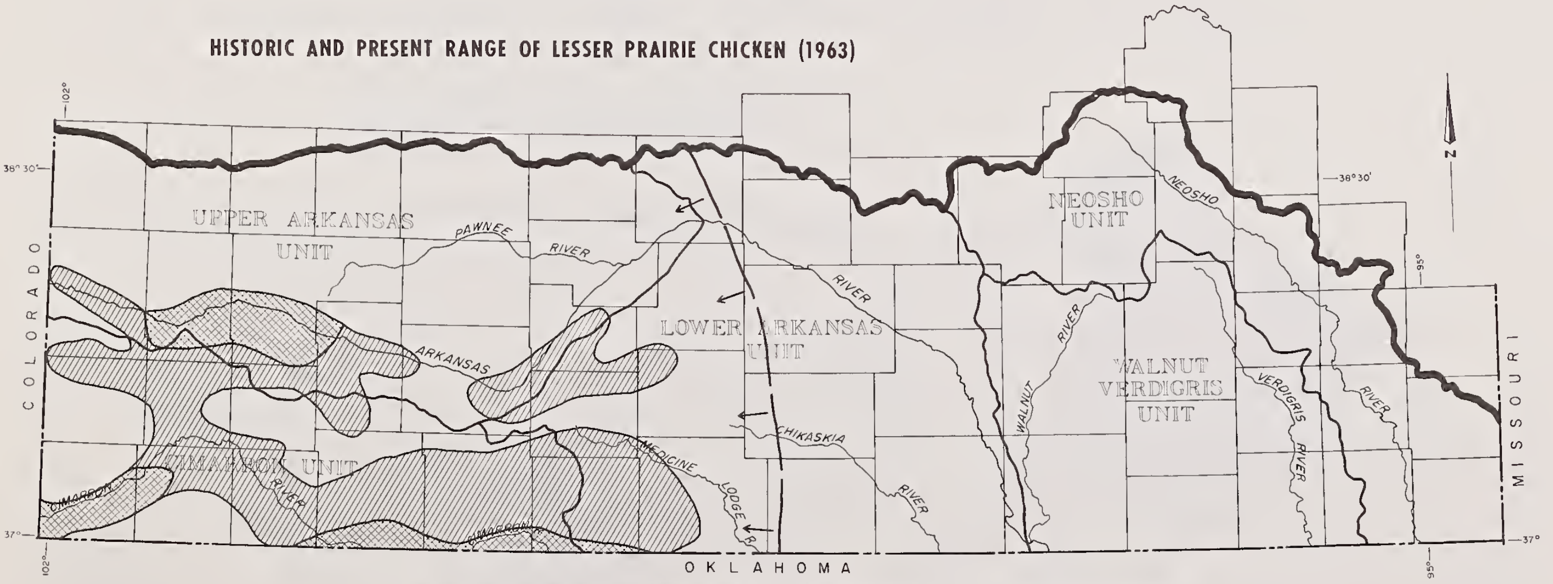
HISTORIC RANGE, PRESENT RANGE, AND RELATIVE DENSITIES OF GREATER PRAIRIE CHICKENS (1964)



ALL AREA NORTH AND EAST OF DASHED LINE IS BELIEVED TO HAVE BEEN GREATER PRAIRIE CHICKEN RANGE.

LOW MEDIUM TO HIGH

HISTORIC AND PRESENT RANGE OF LESSER PRAIRIE CHICKEN (1963)



ALL THE AREA SOUTH AND WEST OF DASHED LINE IS BELIEVED TO HAVE BEEN THE HISTORIC RANGE OF LESSER PRAIRIE CHICKENS.

LOW MEDIUM TO HIGH

SCALE 20 0 20 40 60 MILES

SCALE 1/3,870,000

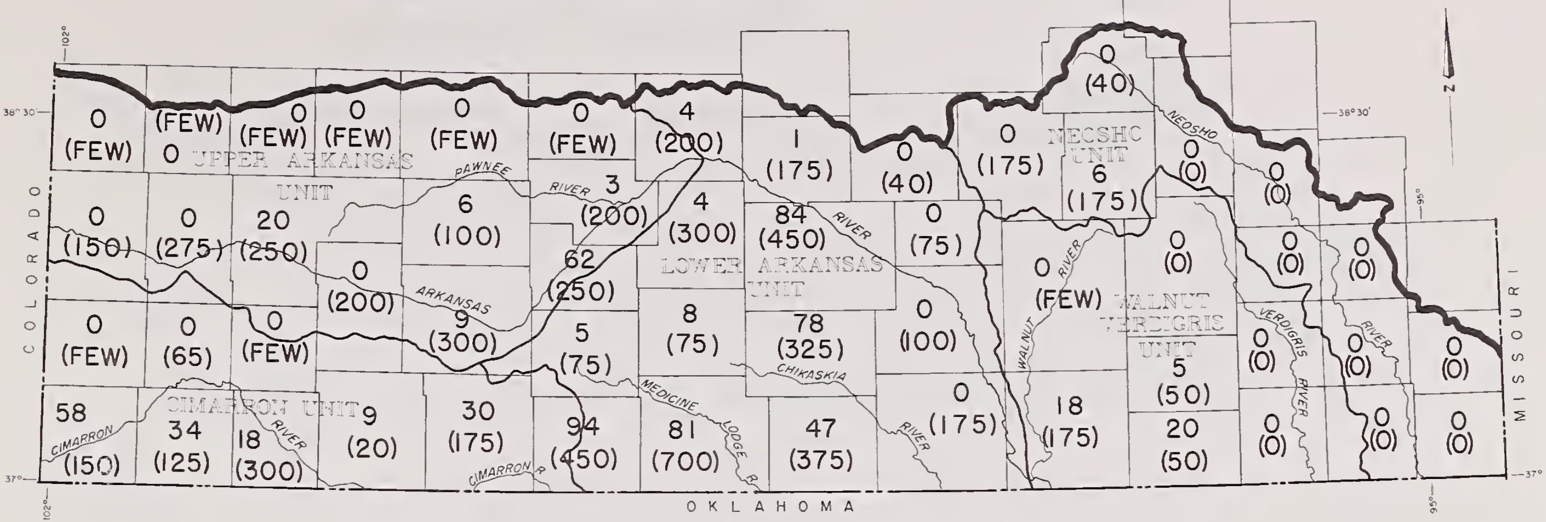
Source: Kansas Forestry, Fish, and Game Commission.

1-27-71
5.S-28,617.2

Exhibit 10

WILDLIFE RESOURCES

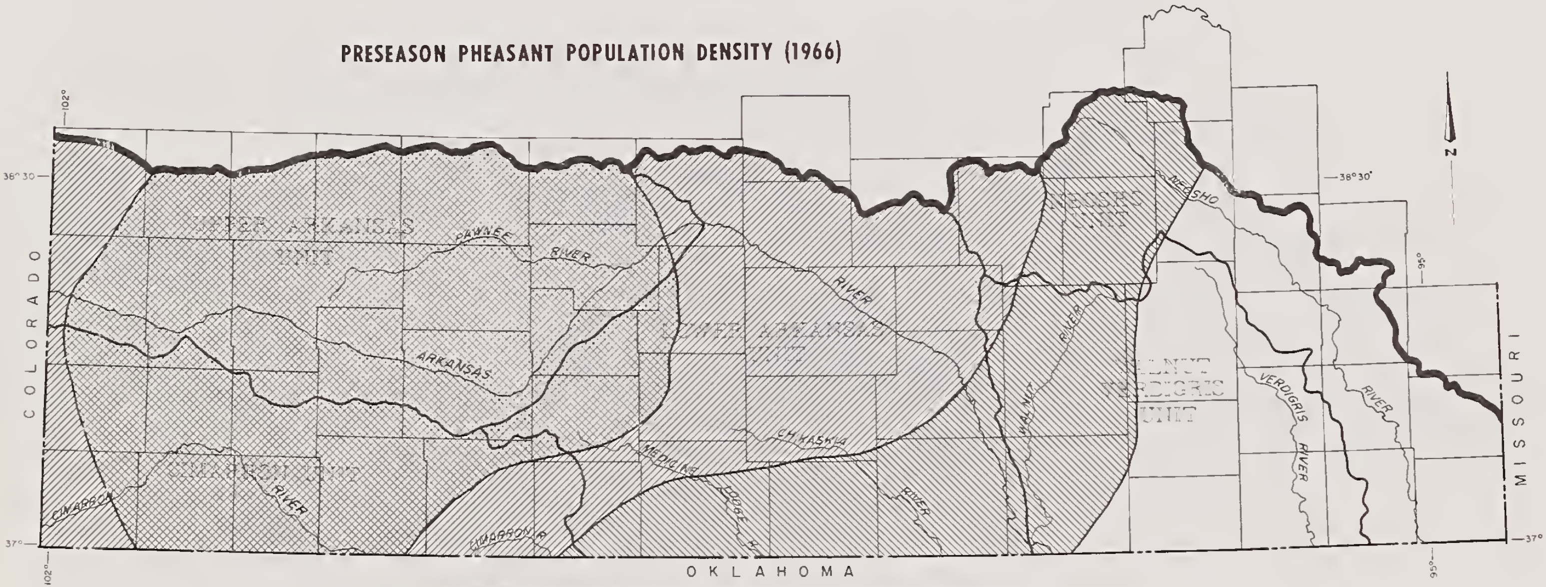
ACTUAL AND POTENTIAL RIO-GRANDE TURKEY POPULATIONS



94 ACTUAL COUNTY POPULATION AS OF JANUARY, 1969

(450) COUNTY POPULATION WHICH HABITAT COULD SUPPORT

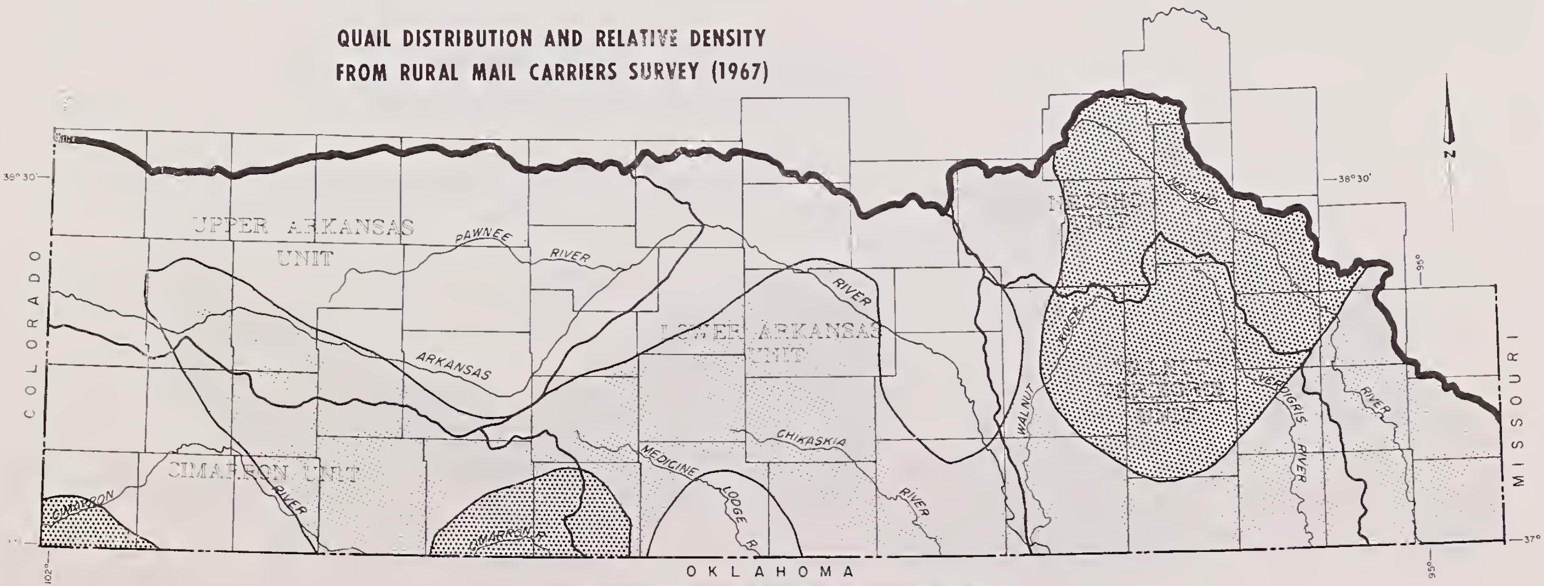
PRESEASON PHEASANT POPULATION DENSITY (1966)



ACTUAL NUMBERS PER SQUARE MILE WILL VARY FROM YEAR TO YEAR BECAUSE OF CHANGES IN CLIMATE AND HABITAT

0–10 PHEASANTS / SQ. MI. 10–50 PHEASANTS / SQ. MI. MORE THAN 50 PHEASANTS / SQ. MI.

QUAIL DISTRIBUTION AND RELATIVE DENSITY FROM RURAL MAIL CARRIERS SURVEY (1967)



POPULATION DENSITY - NUMBER OF QUAIL SEEN PER 100 MILES OF ROUTE

LIGHT (0.0–1.0) MEDIUM (1.1–6.5) HIGH (6.5 & UP)

SCALE 20 0 20 40 60 MILES

SCALE 1/3,870,000

EXHIBIT NO. 10 (CONTD.)

1-26-71
5,S-28617.3

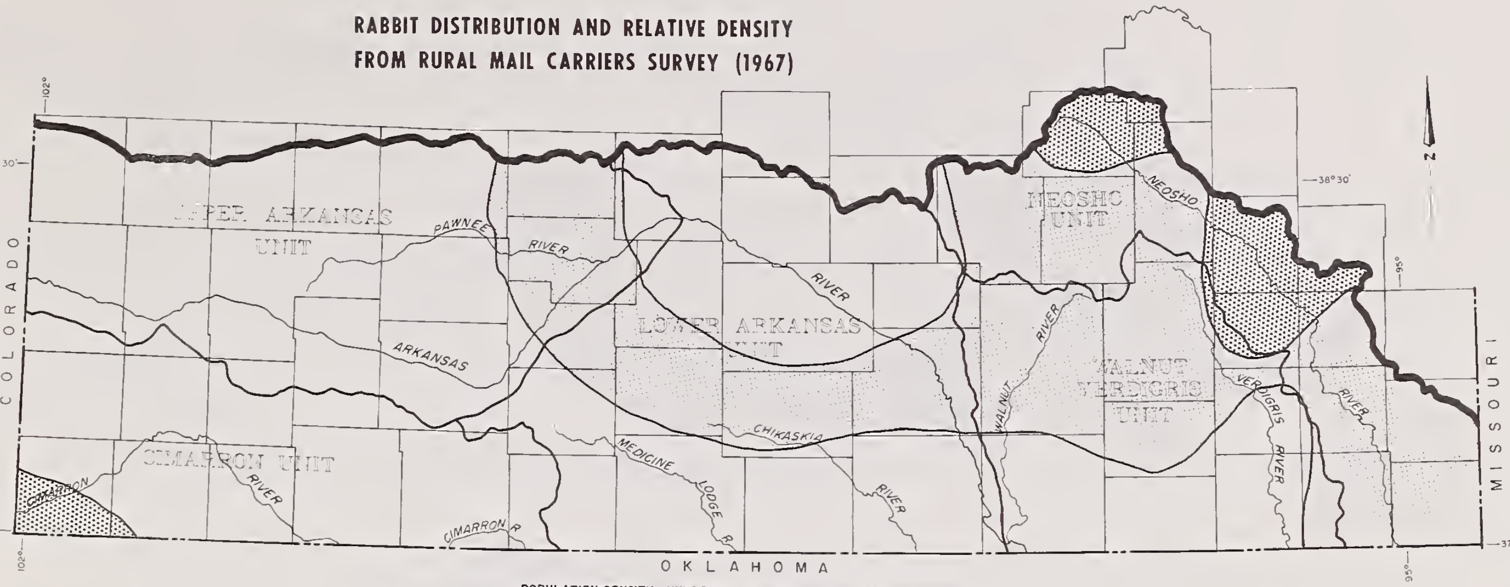
Source: Kansas Forestry, Fish and Game Commission.

USDA-SCS-LINCOLN, NEBR. 1972

Exhibit 10

WILDLIFE RESOURCES

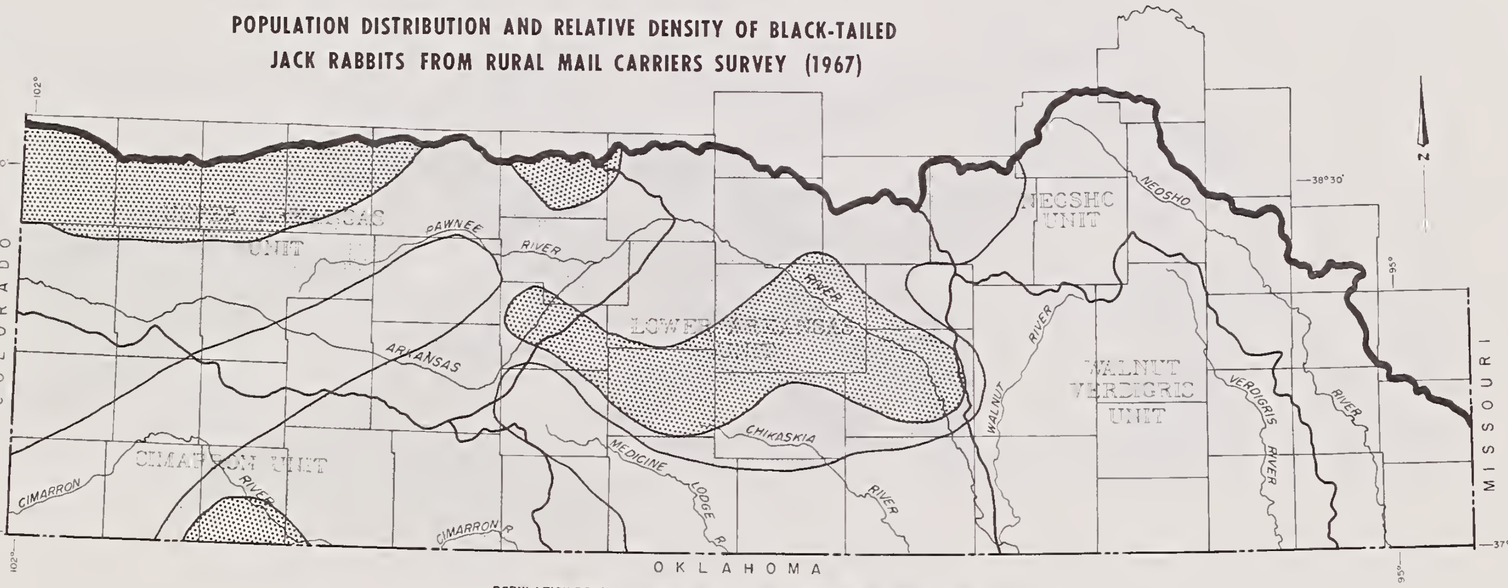
RABBIT DISTRIBUTION AND RELATIVE DENSITY FROM RURAL MAIL CARRIERS SURVEY (1967)



POPULATION DENSITY - NUMBER OF RABBITS SEEN PER 100 MILES OF ROUTE

LIGHT (0.0-0.5) MEDIUM (0.6-1.1) HIGH (1.2-1.9)

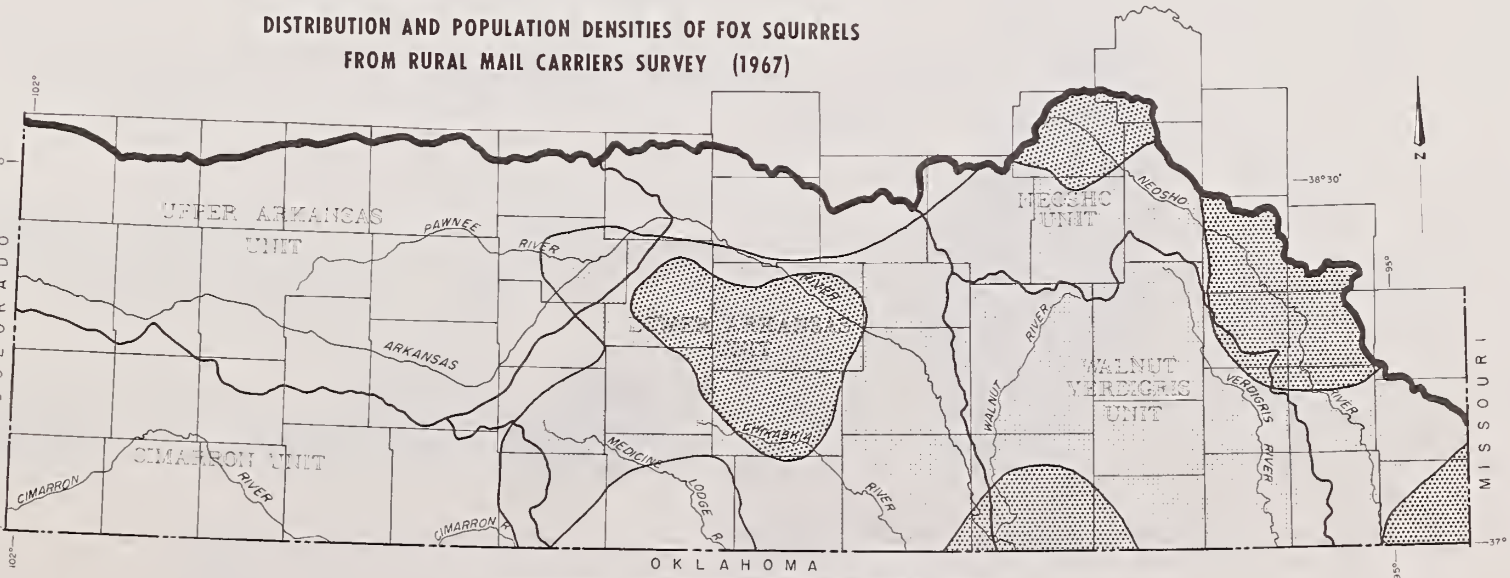
POPULATION DISTRIBUTION AND RELATIVE DENSITY OF BLACK-TAILED JACK RABBITS FROM RURAL MAIL CARRIERS SURVEY (1967)



POPULATION DENSITY - NUMBER OF JACK RABBITS SEEN PER 100 MILES OF ROUTE

LOW (0.0-0.1) MEDIUM (0.1-0.4) HIGH (0.5 & UP)

DISTRIBUTION AND POPULATION DENSITIES OF FOX SQUIRRELS FROM RURAL MAIL CARRIERS SURVEY (1967)



POPULATION DENSITY - NUMBER OF FOX SQUIRRELS SEEN PER 100 MILES OF ROUTE

LOW (0.0-0.4) MEDIUM (0.5-1.0) HIGH (1.1-2.1)

SCALE 20 0 20 40 60 MILES

SCALE 1/3,870,000

Source: Kansas Forestry, Fish, and Game Commission.

1-26-71
5,S-28617.4

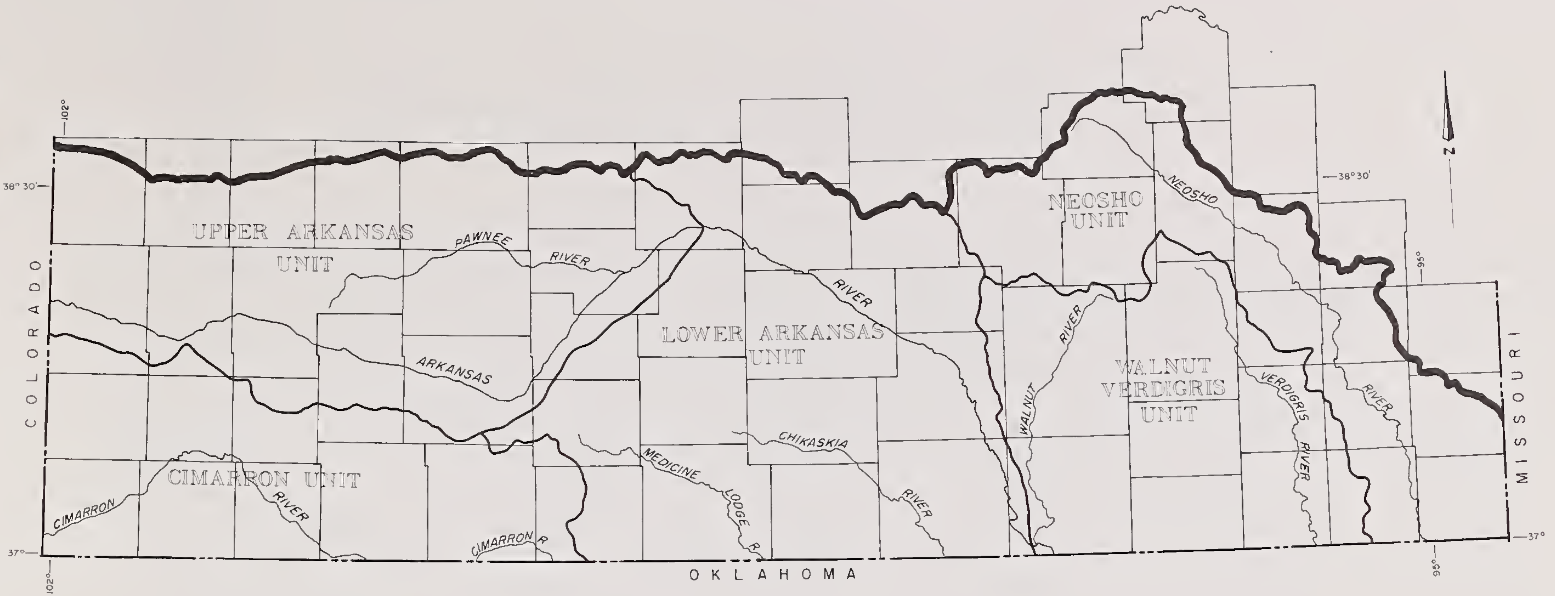
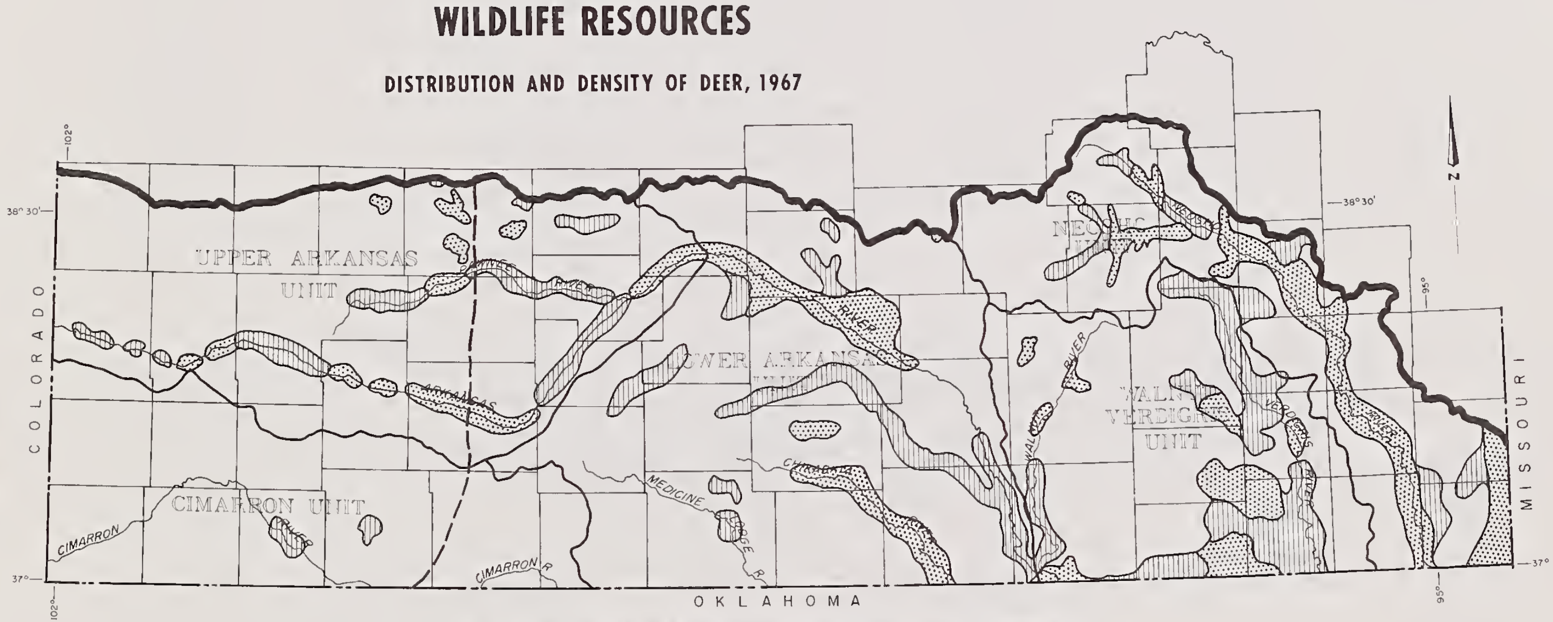


Exhibit 10
WILDLIFE RESOURCES

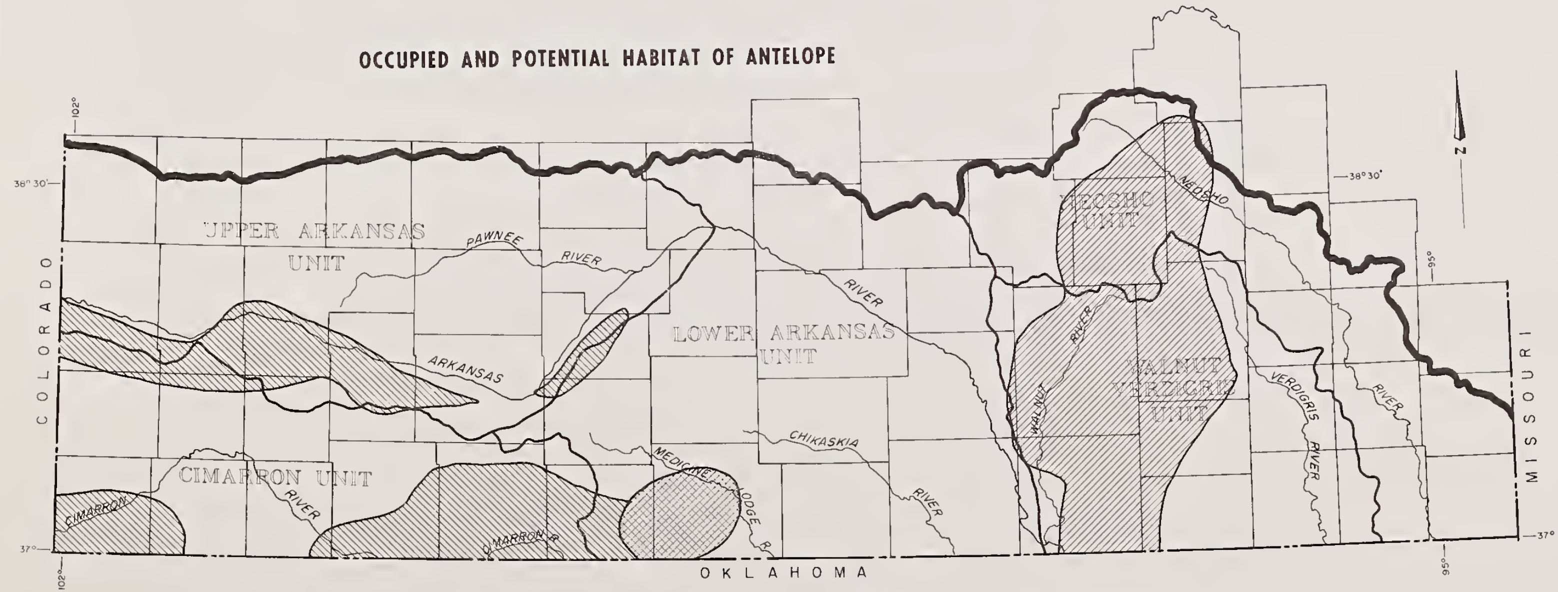
DISTRIBUTION AND DENSITY OF DEER, 1967



WEST OF THE DASHED LINE, MULE DEER PREDOMINATE AND TO THE EAST, WHITE TAILS PREDOMINATE.

LOW MEDIUM HIGH

OCCUPIED AND POTENTIAL HABITAT OF ANTELOPE



OCCUPIED RANGE--APPROXIMATELY 100 ANTELOPE PRESENT

POTENTIAL RANGE

POSSIBLE POTENTIAL RANGE--THIS IS SUBMARGINAL ANTELOPE RANGE HISTORICALLY. EXPERIMENTAL STOCKING MAY BE TRIED IN THE FUTURE.

LITTLE OR NO EXISTING HABITAT

SCALE 20 0 20 40 60 MILES

SCALE 1/3,870,000

Source; Kansas Forestry, Fish, and Game Commission.

EXHIBIT NO. 10 (CONTD.)

-27-71
5,S-28,617.1

Arkansas River Basin-Kansas
Exhibit 11 - Area of Commercial Forest Land by Stand-Size and Ownership Class

Planning Units	Area by Stand-Size Classes (Acres)					
	Sawtimber	Poletimber	Seedlings & Samplings	Nonstocked	Total	%
Cimarron	3,402	993	606	867	5,868	1
Upper Arkansas	5,195	1,671	935	1,269	9,070	2
Lower Arkansas	35,803	10,436	5,359	6,864	58,462	13
Walnut-Verdigris	92,500	32,900	24,600	23,900	173,900	38
Neosho	121,900	28,200	26,800	30,500	207,400	46
Total	258,800	74,200	58,300	63,400	454,700	100

Planning Units	Area by Ownership Classes (Acres)				
	National Grasslands	Other Public	Private	State	Total
Cimarron	0	0	5,868	0	5,868
Upper Arkansas	0	0	9,070	0	9,070
Lower Arkansas	0	0	58,462	0	58,462
Walnut-Verdigris	0	0	173,900	0	173,900
Neosho	0	0	205,100	2,300	207,400
Total	0	0	452,400	2,300	454,700

Source: 1964 Inventory by USDA Forest Service and Kansas State Forest Service

Arkansas River Basin-Kansas

Exhibit 12 - Area of Non-commercial Forest Land by Forest Types

Planning Units	Forest Types	Area (Acres)
Cimarron	Oak-hickory	0
	Elm-ash-cottonwood 1/	500
Upper Arkansas	Oak-hickory	0
	Elm-ash-cottonwood 1/	1,000
Lower Arkansas	Oak-hickory	0
	Elm-ash-cottonwood 1/	5,800
Walnut-Verdigris	Oak-hickory	38,600
	Elm-ash-cottonwood	4,400
Neosho	Oak-hickory	45,000
	Elm-ash-cottonwood	5,100
All types		100,400

1/ Includes willow

Source: 1964 Inventory by USDA Forest Service and Kansas State Forest Service

Arkansas River Basin-Kansas
Exhibit 13 - Volume of Sawtimber Growing Stock on
Commercial Forest Land by Species

Species	Volume (thousand board feet)					
	Cimarron	Upper Arkansas	Lower Arkansas	Walnut-Verdigris	Neosho	All Units
HARDWOODS:						
(1) Bur oak	2,110	2,610	13,940	20,200	27,680	66,540
(2) Other select w.oak	-	-	-	2,990	3,670	6,660
(3) Select red oak	-	-	-	17,400	21,170	38,570
(4) Other white oak	-	-	-	4,710	5,310	10,020
(5) Other red oak	-	-	-	7,780	10,930	18,710
(6) Hickory	-	-	-	3,560	5,270	8,830
(7) Pecan	-	-	-	10,560	16,000	26,560
(8) Hard maple	-	-	-	1,830	2,100	3,930
(9) Ash	600	940	6,470	17,850	23,180	49,040
(10) Black walnut	60	140	1,240	12,390	15,230	29,060
(11) Elm	1,830	2,510	18,190	44,000	65,900	132,430
(12) Hackberry	530	920	6,890	25,020	36,990	70,350
(13) Soft maple	10	10	200	3,430	4,440	8,090
(14) Sycamore	-	-	-	27,140	37,430	64,570
(15) Basswood	-	-	-	330	500	830
(16) Cottonwood	7,110	10,090	58,300	17,300	21,550	114,350
(17) Willow	170	180	660	4,360	4,700	10,070
(18) Other soft hardwoods	110	170	1,120	2,080	2,730	6,210
(19) Other hard hardwoods	50	90	630	2,350	2,940	6,060
(20) Total Hardwoods	12,580	17,660	107,640	225,280	307,720	670,880

Source: 1964 Inventory by USDA Forest Service and Kansas State Forest Service.

Arkansas River Basin-Kansas

Exhibit 14 - Volume of Sawtimber and Growing Stock

Planning Units	Sawtimber (M board feet)			Growing Stock (M cubic feet)			
	Total	In Sawtimber Stands	In Other Stands	Total	Sawtimber	Poletimber	Short Log Trees
Cimarron	12,579	596	11,983	7,745	3,109	2,470	2,166
Upper Arkansas	17,663	1,067	16,596	11,311	4,515	3,546	3,250
Lower Arkansas	107,638	7,117	100,521	71,584	27,756	22,164	21,664
Walnut-Verdigris	225,280	204,420	20,860	94,855	44,800	17,090	32,965
Neosho	307,720	281,750	25,970	119,135	60,860	20,130	38,145
Total	670,880	494,950	175,930	304,630	141,040	65,400	98,190

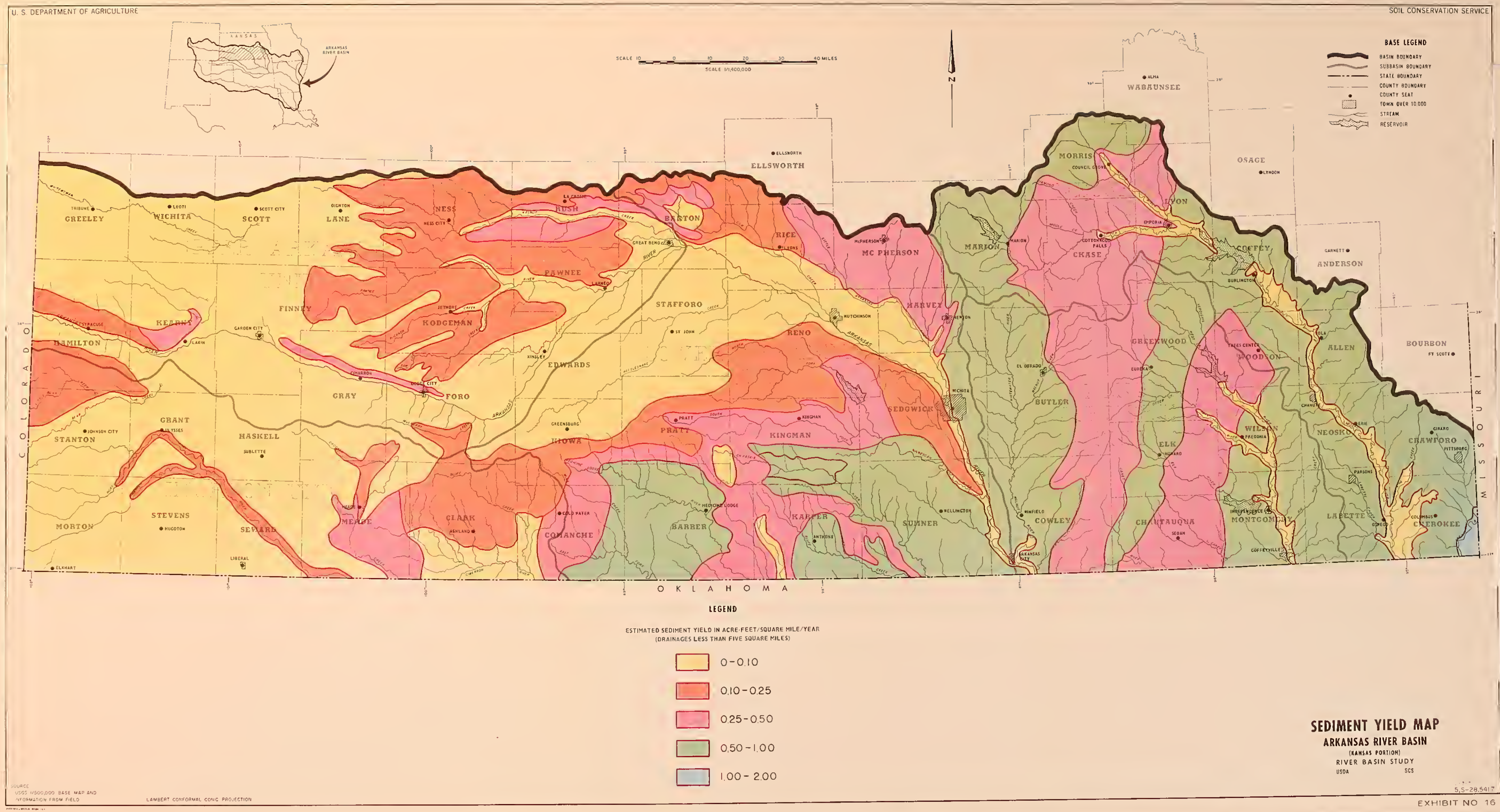
Source: 1964 Inventory by USDA Forest Service and Kansas Forest Service

Arkansas River Basin-Kansas
Exhibit 15 - Annual Timber Cut from Live Sawtimber and Growing Stock on Commercial Forest Land by Product

Products	SAWTIMBER - "All" Species (thousand board feet)					
	Cimarron	Upper Arkansas	Lower Arkansas	Walnut-Verdigris	Neosho	All Units
Roundwood Products						
Saw logs & bolts	0	0	1,166	2,825	4,352	8,343
Veneer logs and bolts	0	0	489	629	768	1,886
Cooperage logs and bolts	0	0	0	580	708	1,288
Mine timber	0	0	1	0	0	1
Posts	1	0	1	5	6	13
Fuelwood	73	79	412	668	1,512	2,744
Charcoal	0	0	0	0	950	950
Total	74	79	2,069	4,707	8,296	15,225

Products	GROWING STOCK - "All" Species (thousand cubic feet)					
	Cimarron	Upper Arkansas	Lower Arkansas	Walnut-Verdigris	Neosho	All Units
Roundwood Products						
Sawlogs & bolts	0	0	190	458	706	1,354
Veneer logs and bolts	0	0	72	94	114	280
Cooperage logs and bolts	0	0	11	81	100	192
Mine timber	0	0	1	0	0	1
Posts	2	1	35	19	22	79
Fuelwood	27	29	150	387	403	996
Charcoal	0	0	0	0	232	232
Total	29	30	459	1,039	1,577	3,134

Source: 1964 Inventory by USDA Forest Service and Kansas State Forest Service


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS
ARKANSAS RIVER BASIN
SCALE 10 0 10 20 30 40 MILES
SCALE 1/1,400,000
N
BASE LEGEND
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WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
ELLSWORTH
RICE
MC PHERSON
MARION
MORRIS
WABAUNSEE
LYON
CHASE
OSAGE
COFFEY
ANDERSON
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
STAFFORD
RENO
HARVEY
BUTLER
GREENWOOD
WOODSON
ALLEN
BOURBON
GRAY
FORD
EDWARDS
KIOWA
PRATT
KINGMAN
SEDGWICK
ELK
WILSON
NEOSHO
CRAWFORD
STANTON
GRANT
HASKELL
MORTON
STEVENS
SEWARD
MEADE
CLARK
COMANCHE
BARBER
HARPER
SUMNER
COWLEY
CHAUTAUQUA
MONTGOMERY
LABETTE
CHEROKEE
COLORADO
OKLAHOMA
MISSOURI
LEGEND
ESTIMATED SEDIMENT YIELD IN ACRE-FEET/SQUARE MILE/YEAR
(DRAINAGES LESS THAN FIVE SQUARE MILES)
0-0.10
0.10-0.25
0.25-0.50
0.50-1.00
1.00-2.00
SEDIMENT YIELD MAP
ARKANSAS RIVER BASIN
(KANSAS PORTION)
RIVER BASIN STUDY
USDA SCS
SOURCE
USGS 1/500,000 BASE MAP AND
INFORMATION FROM FIELD
LAMBERT CONFORMAL CONIC PROJECTION
5,S-28,541
EXHIBIT NO 16

Arkansas River Basin-Kansas
Exhibit 17 - Current Land Treatment Needs
Upper Arkansas Unit

	Land Resource Area								
	072		073		078		079		Total
Cropland Treatment Needs	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Treatment Adequate	1,006,271	26	329,842	49	2,424	41	72,326	39	1,410,863
Residue Management	806,525	21	55,986	8	976	17	56,315	31	919,802
Contour Farming	22,613	1	675	<1	--	--	552	<1	23,840
Stripcropping, Terraces, Diversions	1,564,056	42	271,834	40	2,081	36	51,161	28	1,889,132
Permanent Cover	33,919	1	10,118	2	331	6	1,840	1	46,208
Drainage	7,538	<1	--	--	--	--	184	<1	7,722
Irrigation Systems	301,505	8	6,071	1	--	--	184	<1	307,760
Irrigation Water Management	26,382	1	--	--	--	--	1,472	1	27,854
Total	3,768,809	100	674,526	100	5,812	100	184,034	100	4,633,181
Pasture Treatment Needs									
Treatment Adequate	666,377	42	24,071	14	9,124	69	24,893	38	724,465
Treatment Not Feasible	14,249	1	--	--	26	<1	263	<1	14,538
Proper Grazing Use	458,997	29	139,708	83	3,547	27	34,111	52	636,363
Deferred Grazing	6,588	<1	--	--	--	--	--	--	6,588
Brush Control	226,629	14	4,860	3	444	4	2,269	4	234,202
Range Seeding	212,601	14	--	--	--	--	3,951	6	216,552
Total	1,585,441	100	168,639	100	13,141	100	65,487	100	1,832,708

The total estimated cost of installing the above needed land treatment is $120,100,000.

EXHIBIT NO. 17

Arkansas River Basin-Kansas
Exhibit 17 - Current Land Treatment Needs
Cimarron Unit

Cropland Treatment Needs	072 Acres	072 %	077 Acres	077 %	078 Acres	078 %	Total Acres
Treatment Adequate	267,170	15	177,001	25	135,178	35	579,349
Residue Management	623,995	35	181,937	26	97,887	25	903,819
Contour Farming	193,654	11	15,514	2	--	--	209,168
Stripcropping, Terraces, Diversions	433,926	24	232,711	33	113,425	29	780,062
Permanent Cover	25,103	1	13,399	2	22,918	6	61,420
Drainage	12,552	1	--	--	7,769	2	20,321
Irrigation Systems	173,930	10	65,582	9	5,827	2	245,339
Irrigation Water Management	62,758	3	19,040	3	5,438	1	87,236
Total	1,793,088	100	705,184	100	388,442	100	2,886,714

Land Resource Area

Pasture Treatment Needs	072 Acres	072 %	077 Acres	077 %	078 Acres	078 %	Total Acres
Treatment Adequate	33,479	26	17,567	6	400,865	53	451,911
Treatment Not Feasible	258	<1	308	<1	--	--	566
Proper Grazing Use	74,425	58	149,786	49	264,241	35	488,452
Deferred Grazing	2,704	2	--	--	--	--	2,704
Brush Control	--	--	26,030	8	80,323	11	106,353
Range Seeding	17,898	14	115,266	37	5,255	1	138,419
Total	128,764	100	308,957	100	750,684	100	1,188,405

The total estimated cost of installing the above needed land treatment is $85,600,000.

Arkansas River Basin-Kansas
Exhibit 17 - Current Land Treatment Needs
Lower Arkansas Unit

	Land Resource Area												
Cropland	073		074		075		078		079		080		Total
Treatment Needs	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Treatment Adequate	47,676	41	6,505	19	595,124	43	138,047	41	346,091	30	644,643	38	1,778,086
Residue Management	463	<1	3,495	10	242,559	17	55,616	17	345,046	31	245,337	14	892,516
Contour Farming	--	--	--	--	9,815	1	--	--	3,383	<1	45,683	3	58,881
Stripcropping, Terraces, Diversions	54,850	48	24,600	71	492,129	35	118,515	36	313,472	28	744,469	44	1,748,035
Permanent Cover	12,729	11	--	--	5,608	<1	18,870	6	11,276	1	11,844	1	60,327
Drainage	--	--	--	--	52,635	4	--	--	98,184	9	--	--	150,819
Irrigation Systems	--	--	--	--	--	--	--	--	10,148	1	--	--	10,148
Irrigation Water Management	--	--	--	--	4,206	<1	--	--	--	--	--	--	4,206
Total	115,718	100	34,600	100	1,402,076	100	331,048	100	1,127,600	100	1,691,976	100	4,703,018
Pasture Treatment Needs													
Treatment Adequate	27,992	86	695	11	62,233	26	521,470	70	152,516	38	154,368	23	919,274
Treatment Not Feasible	--	--	--	--	2,286	1	1,507	<1	1,614	<1	6,014	1	11,421
Proper Grazing Use	4,369	14	5,798	89	158,757	67	202,710	27	209,004	53	432,364	66	1,013,002
Deferred Grazing	--	--	--	--	762	<1	--	--	--	--	9,356	1	10,118
Brush Control	--	--	--	--	--	--	23,498	3	13,038	3	24,474	4	61,010
Range Seeding	--	--	--	--	14,747	6	--	--	24,209	6	32,076	5	71,032
Total	32,361	100	6,493	100	238,785	100	749,185	100	400,381	100	658,652	100	2,085,857

The total estimated cost of installing the above needed land treatment is $40,000,000.

Arkansas River Basin-Kansas

Exhibit 17 - Current Land Treatment Needs

Walnut-Verdigris Unit

	Land Resource Area						
	075		076		112		Total
Cropland Treatment Needs	Acres	%	Acres	%	Acres	%	Acres
Treatment Adequate	116,408	35	249,948	49	101,230	27	467,586
Residue Management	47,500	14	77,463	15	127,108	33	252,071
Contour Farming	1,338	<1	7,230	1	16,745	4	25,313
Terraces and Diversions	168,257	51	161,640	31	132,055	35	461,952
Permanent Cover	335	<1	13,943	3	381	<1	14,659
Drainage	669	<1	6,197	1	3,045	1	9,911
Irrigation Systems	--	--	--	--	--	--	--
Irrigation Water Management	--	--	--	--	--	--	--
Total	334,507	100	516,421	100	380,564	100	1,231,492

Pasture Treatment Needs							
Treatment Adequate	68,064	49	952,751	48	146,871	34	1,167,686
Treatment Not Feasible	156	<1	--	--	458	<1	614
Proper Grazing Use	68,461	49	475,346	24	90,136	21	633,943
Deferred Grazing	2,331	2	39,098	2	14,641	4	56,070
Brush Control	--	--	398,877	20	131,280	31	530,157
Range Seeding	--	--	123,467	6	43,924	10	167,391
Total	139,012	100	1,989,539	100	427,310	100	2,555,861

The total estimated cost of installing the above needed land treatment is $21,000,000.

Arkansas River Basin-Kansas
Exhibit 17 - Current Land Treatment Needs
Neosho Unit

	Land Resource Area										
Cropland	074		075		076		112		116		Total
Treatment Needs	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Treatment Adequate	10,668	56	72,453	20	117,716	49	372,712	32	--	--	573,549
Residue Management	--	--	28,908	8	56,553	23	230,170	20	--	--	315,631
Contour Farming	--	--	9,148	2	2,670	1	85,292	7	--	--	97,110
Stripcropping, Terraces, Diversions	8,314	44	251,755	69	58,251	24	415,942	36	1,198	100	735,460
Permanent Cover	--	--	3,659	1	3,155	1	14,021	1	--	--	20,835
Drainage	--	--	--	--	4,369	2	42,062	4	--	--	46,431
Irrigation Systems	--	--	--	--	--	--	4,673	<1	--	--	4,673
Irrigation Water Management	--	--	--	--	--	--	3,505	<1	--	--	3,505
Total	18,982	100	365,923	100	242,714	100	1,168,377	100	1,198	100	1,797,194
Pasture Treatment Needs											
Treatment Adequate	22,211	89	52,647	39	426,230	58	261,848	37	2,995	60	765,931
Treatment Not Feasible	--	--	--	--	--	--	793	<1	--	--	793
Proper Grazing Use	2,661	11	52,245	39	241,753	34	135,685	19	--	--	432,344
Deferred Grazing	--	--	6,178	5	3,719	<1	49,196	7	--	--	59,093
Brush Control	--	--	18,171	14	28,954	4	87,822	12	1,796	36	136,743
Range Seeding	--	--	4,835	3	30,498	4	180,120	25	200	4	215,653
Total	24,872	100	134,076	100	731,154	100	715,464	100	4,991	100	1,610,557

The total estimated cost of installing the above needed land treatment is $24,000,000.

Arkansas River Basin-Kansas
Exhibit 17 - Current Land Treatment Needs
Summary

	Land Resource Areas											
	072		073		074		075		076		077	
Cropland Treatment Needs	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Treatment Adequate	1,273,441	23	377,518	48	17,173	32	783,985	37	367,664	49	177,001	25
Residue Management	1,430,520	26	56,449	7	3,495	7	318,967	15	134,016	18	181,937	26
Contour Farming	216,267	4	675	< 1	--		20,301	1	9,900	1	15,514	2
Stripcropping, Terraces, Diversions	1,997,982	36	326,684	41	32,914	61	912,141	44	219,891	29	232,711	33
Permanent Cover	59,022	1	22,847	3	--		9,602	< 1	17,098	2	13,399	2
Drainage	20,090	< 1	--		--		53,304	3	10,566	1	--	
Irrigation Systems	475,435	8	6,071	1	--		--		--		65,582	9
Irrigation Water Management	89,140	2	--		--		4,206	< 1	--		19,040	3
Total	5,561,897	100	790,244	100	53,582	100	2,102,506	100	759,135	100	705,184	100
Pasture Treatment Needs												
Treatment Adequate	699,856	41	52,063	26	22,906	73	182,944	36	1,378,981	51	17,567	6
Treatment Not Feasible	14,507	1	--		--		2,442	< 1	--		308	< 1
Proper Grazing Use	533,422	31	144,077	72	8,459	27	279,463	55	717,099	26	149,786	49
Deferred Grazing	9,292	1	--		--		9,271	2	42,817	1	--	
Brush Control	226,629	13	4,860	2	--		18,171	3	427,831	16	26,030	8
Range Seeding	230,499	13	--		--		19,582	4	153,965	6	115,266	37
Total	1,714,205	100	201,000	100	31,365	100	511,873	100	2,720,693	100	308,957	100

	Land Resource Areas											
	078		079		080		112		116		Total	
Cropland Treatment Needs	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Treatment Adequate	275,649	38	418,417	32	644,643	38	473,942	31	--		4,809,433	32
Residue Management	154,479	21	401,361	31	245,337	14	357,278	23	--		3,283,839	22
Contour Farming	--		3,935	< 1	45,683	3	102,037	7	--		414,312	3
Stripcropping, Terraces, Diversions	234,021	32	364,633	28	744,469	44	547,997	35	1,198	100	5,614,641	37
Permanent Cover	42,119	6	13,116	1	11,844	1	14,402	1	--		203,449	1
Drainage	7,769	1	98,368	7	--		45,107	3	--		235,204	1
Irrigation Systems	5,827	1	10,332	1	--		4,673	< 1	--		567,920	4
Irrigation Water Management	5,438	1	1,472	< 1	--		3,505	< 1	--		122,801	< 1
Total	725,302	100	1,311,634	100	1,691,976	100	1,548,941	100	1,198	100	15,251,599	100
Pasture Treatment Needs												
Treatment Adequate	931,459	62	177,409	38	154,368	23	408,719	35	2,995	60	4,029,267	43
Treatment Not Feasible	1,533	< 1	1,877	1	6,014	1	1,251	< 1	--		27,932	3
Proper Grazing Use	470,498	31	243,115	52	432,364	66	225,821	20	--		3,204,104	34
Deferred Grazing	--		--		9,356	1	63,837	6	--		134,573	1
Brush Control	104,265	7	15,307	3	24,474	4	219,102	19	1,796	36	1,068,465	11
Range Seeding	5,255	< 1	28,160	6	32,076	5	224,044	19	200	4	809,047	8
Total	1,513,010	100	465,868	100	658,652	100	1,142,774	100	4,991	100	9,273,388	100

EXHIBIT NO. 17 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Projects Authorized for Planning or Construction

(Price Base Work Plan Data)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1] $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Upper Arkansas Unit														
1-68	19.77	2,251	2,251	10,700	6,300	5,800	22,800	300	--	19,800[2]	--	20,100	4,700	47,600
1-77	13.60	264	264	1,700	400	700	2,800	200	--	2,000[3]	--	2,200	700	5,700
Subtotal	33.37	2,515	2,515	12,400	6,700	6,500	25,600	500	--	21,800	--	22,300	5,400	53,300
1k-1	367.05	Insignificant floodplain damage												
1k-2	307.70	4,132	4,132	10,200	2,700	--	12,900	200	--	--	--	200	1,300	14,400
1k-3	300.52	1,369	1,369	2,000	600	600	3,200	500	--	8,800	--	9,300	400	12,900
1k-4	397.25	16,629	16,629	86,000	22,200	15,900	124,100	5,600	1,300	6,200	100	13,200	15,700	153,000
1k-5	217.67	14,323	14,323	197,200	3,900	20,700	221,800	7,600	700	14,400	--	22,700	25,600	270,100
Subtotal	1,590.19	36,453	36,453	295,400	29,400	37,200	362,000	13,900	2,000	29,400	100	45,400	43,000	450,400
Unit Total	1,623.56	38,968	38,968	307,800	36,100	43,700	387,600	14,400	2,000	51,200	100	67,700	48,400	503,700
Lower Arkansas Unit														
1-95	33.81	4,870	4,870	37,700	2,100	--	39,800	2,200	400	800[4]	--	3,400	4,500	47,700
1-96	26.09	4,181	4,181	12,300	1,000	--	13,300	6,400	1,800	5,500[5]	--	13,700	2,700	29,700
1-100	10.56	551	551	7,800	900	--	8,700	--	--	4,400[6]	--	4,400	1,500	14,600
Subtotal	70.46	9,602	9,602	57,800	4,000	--	61,800	8,600	2,200	10,700	--	21,500	8,700	92,000
1n-4	99.62	4,452[7]	4,452[7]	24,000	6,800	6,500	37,300	10,300	400	1,200[8]	--	11,900	5,500	54,700
101-7	30.47	962	962	4,000	3,500	6,400	13,900	7,500	--	--	--	7,500	1,500	22,900
Unit Total	200.55	15,016	15,016	85,800	14,300	12,900	113,000	26,400	2,600	11,900	--	40,900	15,700	169,600
Walnut-Verdigris Unit														
1p-1	282.35	6,998	6,998	91,700	7,500	8,800	108,000	21,200	--	--	--	21,200	14,000	143,200
1p-2	234.45	5,650	5,650	93,700	3,500	7,100	104,300	11,000	100	--	--	11,100	12,100	127,500
1p-3	181.23	3,922	3,922	40,900	2,500	5,600	49,000	5,600	--	--	--	5,600	5,800	60,400
1p-4	267.48	6,418	6,418	87,000	6,900	12,000[9]	105,900	8,700	--	--	--	8,700	11,600	126,200
1p-5 & 9	293.13	8,429[10]	8,429[10]	66,900	12,200[11]	9,600	88,700	6,800	--	1,200[12]	--	8,000	10,100	106,800
1p-6	269.75	13,800	13,800	191,400	23,200	26,900	241,500	24,200	--	--	--	24,200	25,100	290,800
1p-7	46.97	1,362	1,362	13,000	2,300	1,600	16,900	3,500	1,200	--	300[13]	5,000	2,300	24,200
1p-8	133.74	6,222	6,222	84,500	19,400	19,100	123,000	12,700	600	--	--	13,300	12,400	148,700
1p-10	162.17	8,282	8,282	123,000	25,200	11,900	160,100	34,300	1,700	--	--	36,000	20,700	216,800
Subtotal	1,871.27	61,083	61,083	792,100	102,700	102,600	997,400	128,000	3,600	1,200	300	133,100	114,100	1,244,600

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EXHIBIT NO. 18

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Projects Authorized for Planning or Construction

(Price Base Work Plan Data)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture 1/ $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Walnut-Verdigris Unit, continued														
1s-1	327.49	19,564	19,564	247,500	16,000	69,400	332,900	8,000	4,200	9,300 14/	1,900	23,400	29,900	386,200
1s-12	219.88	9,240	9,240	88,200	17,700	25,600	131,500	22,300	--	--	--	22,300	16,500	170,300
1s-13	197.37	10,368	10,368	153,200	20,900	24,400	198,500	28,800	100	4,200 15/	400 13/	33,500	24,900	256,900
1s-14	50.58	3,586	3,586	48,200	4,900	3,000	56,100	4,200	--	--	--	4,200	6,200	66,500
Subtotal	795.32	42,758	42,758	537,100	59,500	122,400	719,000	63,300	4,300	13,500	2,300	83,400	77,500	879,900
1s1-1	316.86	16,015	16,015	127,200	71,100 11/	55,900	254,200	25,900	4,000	5,400 16/	--	35,300	25,500	315,000
1s2-1	342.28 17/	13,750	13,750	173,000	28,500	66,300	267,800	21,800	1,400	--	--	23,200	23,600	314,600
1s2-2	39.89	1,333	1,333	13,700	4,100	7,000	24,800	3,000	--	--	--	3,000	2,200	30,000
1s2-3	157.78	5,530	5,530	85,500	8,000	34,700	128,200	14,100	500	--	--	14,600	11,700	154,500
1s2-4	158.30	9,730	9,730	199,200	15,600	58,300	273,100	16,200	7,900	--	--	24,100	25,200	322,400
1s2-5	71.42	4,430	4,430	98,100	4,600	11,900	114,600	10,000	--	--	--	10,000	12,300	136,900
Subtotal	767.67	34,773	34,773	569,500	60,800	178,200	808,500	65,100	9,800	--	--	74,900	75,000	958,400
Unit Total	3,751.12	154,629	154,629	2,025,900	294,100	459,100	2,779,100	282,300	21,700	20,100	2,600	326,700	292,100	3,397,900
Neosho Unit														
1t-8	133.56	6,438	6,438	71,600	3,100	16,500	91,200	5,900	--	--	--	5,900	10,200	107,300
1t1-9	17.82	1,159	1,159	9,400	3,400	7,100	19,900	1,200	--	--	--	1,200	1,400	22,500
Unit Total	151.38	7,597	7,597	81,000	6,500	23,600	111,100	7,100	--	--	--	7,100	11,600	129,800
Basin Total	5,726.61	216,210	216,210	2,500,500	351,000	539,300	3,390,800	330,200	26,300	83,200	2,700	442,400	367,800	4,201,000

1/ Crop yields projected to year 1980
2/ City of Lakin
3/ City of Cimarron
4/ City of Mount Hope
5/ City of Andale
6/ City of Wellington
7/ Does not include floodplain area within Newton
8/ City of Newton
9/ Includes $2,700 sediment reduction to private recreation lake (Fox Lake) with 70 cabins and 185 surface acres
10/ Does not include area of Walnut River floodplain
11/ Includes damage from Johnsongrass
12/ Suburbs of Wichita - Windsor Part and Springdale
13/ Oil fields
14/ City of Madison
15/ City of Moline
16/ City of Eureka
17/ 14 additional square miles in Oklahoma

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Early Action Projects

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1/] $	Agri.: Other Agri. $	Agri.: Land $	Agri.: Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Non-Agri.: Rail-road $	Non-Agri.: Urban $	Non-Agri.: Other $	Non-Agri.: Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Upper Arkansas Unit														
1-61	85.78	1,306	1,306	15,300	10,300	300	25,900	700	400	--	--	1,100	2,700	29,700
1-65	375.43	32,382	32,382	255,700	35,800	--	291,500	13,800	500	--	--	14,300	31,300	337,100
1-85	18.50	1,384	1,384	7,800	6,900	--	14,700	500	--	--	--	500	1,500	16,700
1-87	396.86	22,204	22,204	85,100	12,200	--	97,300	17,900	200	--	--	18,100	12,400	127,800
1-89	137.93	9,204	9,204	82,500	20,500	400	103,400	3,300	--	--	--	3,300	10,800	117,500
Subtotal	1,014.50	66,480	66,480	446,400	85,700	700	532,800	36,200	1,100	--	--	37,300	58,700	628,800
1j-1	543.22	3,629	3,629	25,200	2,900	--	28,100	1,200	--	--	--	1,200	3,000	32,300
1j-2	297.05	8,386	8,386	31,600	7,600	--	39,200	2,500	--	--	--	2,500	4,300	46,000
1j-3	172.91	2,190	2,190	6,700	1,100	--	7,800	400	--	--	--	400	800	9,000
1j-4	203.87	7,306	7,306	6,700	2,500	--	9,200	1,800	--	--	--	1,800	1,200	12,200
1j-5	202.42	17,766	17,766	36,700	13,000	2,800	52,500	10,000	--	--	--	10,000	6,700	69,200
1j-6	431.93	29,852	29,852	145,700	44,200	11,800	201,700	32,000	9,500	--	--	41,500	26,400	269,600
Subtotal	1,851.40	69,129	69,129	252,600	71,300	14,600	338,500	47,900	9,500	--	--	57,400	42,400	438,300
1jl-1	370.05	2,606	2,606	3,100	1,500	--	4,600	1,100	--	--	--	1,100	600	6,300
1jl-2	361.56	12,522	12,522	19,900	5,200	300	25,400	3,300	--	--	--	3,300	2,800	31,500
1jl-3	134.25	4,843	4,843	31,400	5,900	900	38,200	4,400	--	--	--	4,400	4,100	46,700
Subtotal	865.86	19,971	19,971	54,400	12,600	1,200	68,200	8,800	--	--	--	8,800	7,500	84,500
1i-2	476.93[2/]	Insignificant floodplain damage												
1i-3	352.02	3,762	3,762	19,500	4,100	--	23,600	400	--	--	--	400	2,400	26,400
1i-4	271.98	15,785	15,785	197,100	19,900	--	217,000	3,600	500	--	--	4,100	22,300	243,400
1i-5	138.64	5,092	5,092	90,400	5,100	--	95,500	200	--	--	--	200	9,600	105,300
Subtotal	1,239.57	24,639	24,639	307,000	29,100	--	336,100	4,200	500	--	--	4,700	34,300	375,100
1k-6	163.84	18,807	18,807	27,000	3,700	200	30,900	8,300	--	3/	200	8,500	4,400	43,800
Unit Total	5,135.17	199,026	199,026	1,087,400	202,400	16,700	1,306,500	105,400	11,100	--	200	116,700	147,300	1,570,500
Lower Arkansas Unit														
1m-1	170.86	7,108	7,108	48,100	8,900	--	57,000	18,000	--	4,400[4/]	1,000[5/]	23,400	9,200	89,600
1m-2	400.69	12,318	12,318	29,300	10,500	--	39,800	19,100	--	--	1,500[5/]	20,600	7,100	67,500
1m-3	353.27	9,086	9,086	86,900	9,700	--	96,600	22,200	200	--	4,100[5/]	26,500	13,700	136,800
Subtotal	924.82	28,512	28,512	164,300	29,100	--	193,400	59,300	200	4,400	6,600	70,500	30,000	293,900
1n-1	321.33	19,414	19,414	145,900	18,100	3,400	167,400	46,400	3,200	--	1,600[5/]	51,200	24,400	243,000
1q2-6	138.33	5,622	5,622	51,800	4,000	1,400	57,200	11,600	300	--	100[5/]	12,000	7,500	76,700
Unit Total	1,384.48	53,548	53,548	362,000	51,200	4,800	418,000	117,300	3,700	4,400	8,300	133,700	61,900	613,600

Footnotes on page 4 of 12

EXHIBIT NO. 18 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18, Average Annual Damages
Early Action Projects

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1/] $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Walnut-Verdigris Unit														
1s-10	58.63	2,205	2,205	23,200	1,900	1,600	26,700	4,200	--	--	--	4,200	3,300	34,200
1s-19	115.24	6,410	6,410	72,800	6,200	3,000	82,000	12,700	500	9,600[6/]	200[5/]	23,000	11,600	116,600
Unit Total	173.87	8,615	8,615	96,000	8,100	4,600	108,700	16,900	500	9,600	200	27,200	14,900	150,800
Neosho Unit														
1t-2	128.98	8,330	8,330	150,300	9,700	9,800	169,800	13,100	--	2,400[7/]	100[5/]	15,600	19,300	204,700
1t-5	124.54	8,717	8,717	112,800	8,500	8,000	129,300	16,400	--	--	--	16,400	15,400	161,100
1t-7	201.94	11,376	11,376	186,000	12,000	7,100	205,100	24,400	300	--	--	24,700	23,500	253,300
1t-10	57.31	3,693	3,693	40,200	2,900	2,400	45,500	6,300	--	--	--	6,300	5,500	57,300
1t-13	117.48	5,960	5,960	109,800	5,000	5,000	119,800	11,500	--	--	2,800[5/]	14,300	14,200	148,300
1t-15	150.99	9,794	9,794	109,200	8,500	6,300	124,000	10,900	200	--	3,900[5/]	15,000	14,700	153,700
1t-18	84.42	4,957	4,957	60,700	3,000	3,000	66,700	7,400	--	--	--	7,400	7,700	81,800
1t-22	126.11	3,722	3,722	48,800	3,800	1,500	54,100	6,300	--	--	--	6,300	6,400	66,800
1t-23	252.22	13,800	13,800	138,800	13,700	2,500	155,000	20,000	900	--	--	20,900	18,700	194,600
1t-24	238.72	13,137	13,137	143,400	16,000	4,500	163,900	19,800	300	--	100[8/]	20,200	19,400	203,500
1t-25	116.56	8,192	8,192	109,700	7,200	2,300	119,200	16,800	700	--	--	17,500	14,600	151,300
1t-27	62.16	2,816	2,816	27,600	2,700	400	30,700	4,800	--	--	--	4,800	3,800	39,300
Subtotal	1,661.43	94,494	94,494	1,237,300	93,000	52,800	1,383,100	157,700	2,400	2,400	6,900	169,400	163,200	1,715,700
1t1-3	151.67	5,229	5,229	100,100[9/]	9,600	8,700	118,400	15,600	1,500	--	--	17,100	14,100	149,600
1t1-4	114.95	4,197	4,197	84,300[9/]	6,100	5,200	95,600	12,300	--	--	--	12,300	11,400	119,300
1t1-5	88.32	5,203	5,203	49,400	4,100	5,900	59,400	10,100	2,400	--	--	12,500	7,800	79,700
1t1-6	39.60	3,546	3,546	62,000	3,500	2,700	68,200	8,700	1,600	--	--	10,300	8,400	86,900
1t1-7	302.52	19,100	19,100	239,700	13,300	14,100	267,100	46,800	6,100	--	--	52,900	34,600	354,600
1t1-8	234.65	15,712	15,712	260,900	11,300	12,600	284,800	38,900	5,000	--	--	43,900	35,100	363,800
1t1-11	135.31	21,042	21,042	335,600	12,200	14,000	361,800	58,500	5,100	--	--	63,600	45,700	471,100
1t1-12	280.52	10,858	10,858	134,900	13,400	18,100	166,400	11,800	2,900	100[10/]	--	14,800	18,900	200,100
Subtotal	1,347.54	84,887	84,887	1,266,900	73,500	81,300	1,421,700	202,700	24,600	100	--	227,400	176,000	1,825,100
1t2-19	245.25	11,160	11,160	146,900	12,900	3,700	163,500	20,000	1,200	100[11/]	--	21,300	19,500	204,300
Unit Total	3,254.22	190,541	190,541	2,651,100	179,400	137,800	2,968,300	380,400	28,200	2,600	6,900	418,100	358,700	3,745,100
Basin Total	9,947.74	451,730	451,730	4,196,500	441,100	163,900	4,801,500	620,000	43,500	16,600	15,600	695,700	582,800	6,080,000

1/ Crop yields projected to year 1980
2/ An additional 240 square miles of drainage located in Colorado
3/ Damages from Corps evaluated area not included
4/ City of Hoisington
5/ Oil field
6/ City of Coffeyville
7/ City of Dunlap
8/ Golf course, city of Parsons
9/ Crop yields projected to year 2000
10/ City of Bazaar
11/ City of Girard

EXHIBIT NO. 18 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Long Range Projects

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1/] $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Upper Arkansas Unit														
1-57	34.79[2/]	614	614	8,400	5,500	--	13,900	100	--	--	--	100	1,400	15,400
1-62	93.97	905	905	5,700	2,900	300	8,900	500	--	--	--	500	1,000	10,400
Unit Total	128.76	1,519	1,519	14,100	8,400	300	22,800	600	--	--	--	600	2,400	25,800
Cimarron Unit														
1rl(a)-4	105.33	Insignificant floodplain damages												
1rl(a)-5	102.83	Insignificant floodplain damages												
1rl(a)-6	80.80	2,759	2,759	9,700	3,400	300	13,400	2,000	--	--	--	2,000	1,500	16,900
Unit Total	288.96	2,759	2,759	9,700	3,400	300	13,400	2,000	--	--	--	2,000	1,500	16,900
Lower Arkansas Unit														
1q2-7	56.41	1,954	1,954	7,600	900	1,200	9,700	5,300	--	--	100[3/]	5,400	1,800	16,900
Unit Total	56.41	1,954	1,954	7,600	900	1,200	9,700	5,300	--	--	100	5,400	1,800	16,900
Walnut-Verdigris Unit														
1s-2	123.31	5,952	5,952	54,000	4,400	8,500	66,900	11,000	--	--	1,300[3/]	12,300	8,600	87,800
1s-3	178.12	5,422	5,422	42,600	4,200	4,100	50,900	9,000	1,800	100[4/]	--	10,900	6,700	68,500
1s-4	57.82	1,607	1,607	18,600	1,500	2,700	22,800	1,700	--	--	200[3/]	1,900	2,600	27,300
1s-6	67.34	3,405	3,405	25,600	2,600	2,900	31,100	6,800	--	--	1,400[3/]	8,200	4,300	43,600
1s-7	112.68	4,203	4,203	52,600	3,900	4,100	60,600	5,900	300	--	800[3/]	7,000	7,100	74,700
1s-8	121.14	4,176	4,176	32,900	3,200	3,400	39,500	8,300	100	--	100[3/]	8,500	5,200	53,200
1s-11	29.56	1,664	1,664	17,300	1,300	1,100	19,700	3,700	200	--	1,200[3/]	5,100	2,700	27,500
1s-15	215.65	7,486	7,486	65,000	6,400	4,500	75,900	8,200	--	--	--	8,200	8,800	92,900
1s-16	148.71	1,725	1,725	15,100	2,500	1,600	19,200	5,200	200	300[5/]	--	5,700	2,800	27,700
1s-17	91.95	5,056	5,056	31,700	3,700	3,500	38,900	8,000	200	--	300[3/]	8,500	5,200	52,600
1s-20	152.11	7,190	7,190	58,900	5,300	2,900	67,100	12,100	100	--	--	12,200	8,500	87,800
1s-21	40.48	1,170	1,170	13,300	1,200	500	15,000	2,500	--	--	--	2,500	1,900	19,400
Subtotal	1,338.87	49,056	49,056	427,600	40,200	39,800	507,600	82,400	2,900	400	5,300	91,000	64,400	663,000
1sl-2	151.39	4,993	4,993	35,400	3,600	5,700	44,700	8,200	--	--	--	8,200	5,700	58,600
1sl-4	174.23	4,996	4,996	35,900	3,700	5,500	45,100	9,600	600	--	--	10,200	6,000	61,300
Subtotal	325.62	9,989	9,989	71,300	7,300	11,200	89,800	17,800	600	--	--	18,400	11,700	119,900

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EXHIBIT NO. 18 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Long Range Projects

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1/] $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Walnut-Verdigris Unit, continued														
1-103	87.71	3,594	3,594	25,200	3,900	3,800	32,900	2,700	100	--	700[3/]	3,500	3,800	40,200
1-104	291.35	13,152	13,152	124,800	17,700	21,300	163,800	20,100	1,500	--	1,600[3/]	23,200	19,900	206,900
1-105	39.52[6/]	2,111	2,111	16,500	1,900	5,000	23,400	4,400	600	--	--	5,000	3,100	31,500
Subtotal	418.58	18,857	18,857	166,500	23,500	30,100	220,100	27,200	2,200	--	2,300	31,700	26,800	278,600
Unit Total	2,083.07	77,902	77,902	665,400	71,000	81,100	817,500	127,400	5,700	400	7,600	141,100	102,900	1,061,500
Neosho Unit														
1t-1	325.73	13,074	13,074	185,000	11,000	13,900	209,900	24,400	300	1,900[7/]	--	26,600	25,000	261,500
1t-3	71.51	3,564	3,564	55,500	3,700	4,500	63,700	5,300	--	--	--	5,300	7,100	76,100
1t-4	101.80	2,091	2,091	23,100	1,300	2,300	26,700	2,400	--	--	--	2,400	3,100	32,200
1t-6	377.01	7,826	7,826	77,700	5,300	6,300	89,300	13,200	--	--	--	13,200	11,000	113,500
1t-9	75.34	3,793	3,793	27,000	3,000	2,200	32,200	7,000	--	--	600[3/]	7,600	4,400	44,200
1t-12	109.11	3,526	3,526	28,800	3,400	1,000	33,200	7,400	--	--	300[3/]	7,700	4,400	45,300
1t-14	91.28	3,616	3,616	25,000	7,600	800	33,400	8,100	200	1,100[8/]	--	9,400	4,700	47,500
1t-16	201.21	7,205	7,205	84,900	5,600	2,900	93,400	11,800	100	--	--	11,900	11,100	116,400
1t-19	149.82	6,758	6,758	86,800	6,700	2,000	95,500	8,800	400	--	400[3/]	9,600	11,000	116,100
1t-20	103.76	3,342	3,342	30,000	2,900	1,300	34,200	5,900	--	--	800[3/]	6,700	4,400	45,300
1t-21	167,41	2,374	2,374	15,700	3,300	700	19,700	4,300	--	--	--	4,300	2,600	26,600
1t-26	147.13	7,501	7,501	99,800	7,900	2,200	109,900	10,600	--	--	--	10,600	12,600	133,100
Subtotal	1,921.11	64,670	64,670	739,300	61,700	40,100	841,100	109,200	1,000	3,000	2,100	115,300	101,400	1,057,800
1t1-1	330.73	9,562	9,562	116,100	9,200	7,300	132,600	25,400	--	--	--	25,400	17,100	175,100
1t1-2	172.84	8,063	8,063	95,600	4,300	5,800	105,700	26,600	2,500	--	400[3/]	29,500	15,000	150,200
1t1-10	38.39	3,221	3,221	55,800	1,900	2,000	59,700	6,300	--	--	--	6,300	6,900	72,900
Subtotal	541.96	20,846	20,846	267,500	15,400	15,100	298,000	58,300	2,500	--	400	61,200	39,000	398,200
1t2-20	207.36	6,373	6,373	58,800	6,800	1,800	67,400	14,400	500	--	--	14,900	8,900	91,200
Unit Total	2,670.43	91,889	91,889	1,065,600	83,900	57,000	1,206,500	181,900	4,000	3,000	2,500	191,400	149,300	1,547,200
Basin Total	5,227.63	176,023	176,023	1,762,400	167,600	139,900	2,069,900	317,200	9,700	3,400	10,200	340,500	257,900	2,668,300

1/ Crop yields projected to year 1980
2/ An additional 23,700 square miles of contributing drainage area above this watershed in Colorado
3/ Oil field
4/ City of Neal
5/ City of Independence
6/ East part of the subarea
7/ City of Council Grove
8/ City of Iola

EXHIBIT NO. 18 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Projects Not Feasible

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Acre Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1/] $	Agri.: Other Agri. $	Agri.: Land $	Agri.: Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Non-Agri.: Rail-road $	Non-Agri.: Urban $	Non-Agri.: Other $	Non-Agri.: Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Upper Arkansas Unit														
1-58	167.44	Insignificant floodplain damage												
1-60	106.90	907	907	9,300	5,700	200	15,200	600	--	--	--	600	1,600	17,400
1-63	108.27	145	145	1,700	1,600	100	3,400	200	--	--	--	200	400	4,000
1-64	242.08	1,605	1,605	4,900	1,600	--	6,500	600	--	--	--	600	700	7,800
1-66	132.37	Insignificant floodplain damage												
1-67	96.22	"	"	"										
1-69	141.08	730	730	4,500	700	--	5,200	300	--	--	--	300	600	6,100
1-70	70.33	Insignificant floodplain damage												
1-71	87.37	"	"	"										
1-72	58.75	"	"	"										
1-73	45.99	"	"	"										
1-74	75.81	"	"	"										
1-75	924.68	"	"	"										
1-76	113.37	2,031	2,031	25,900	20,300	600	46,800	200	--	--	--	200	4,700	51,700
1-73	106.57	Insignificant floodplain damage												
1-79	20.97	"	"	"										
1-80	28.54	"	"	"										
1-81	17.01	"	"	"										
1-82	28.71	"	"	"										
1-83	91.13	"	"	"										
1-84	205.73	5,985	5,985	7,800	3,100	--	10,900	1,400	200	--	--	1,600	1,300	13,300
1-86	224.70	Insignificant floodplain damage												
1-88	341.34	"	"	"										
Unit Total	3,435.36	11,403	11,403	54,100	33,000	900	88,000	3,300	200	--	--	3,500	9,300	100,800
Cimarron Unit														
1r	3,942.89	Insignificant floodplain damages in subbasin 1r												
1r1-5	117.28	Insignificant floodplain damages												
1r1-6	145.17	3,141	3,141	3,900	2,400	400	6,700	1,700	--	--	--	1,700	1,000	9,400
1r1-7	296.02	Insignificant floodplain damages												
1r1-8	90.35	4,911	4,911	4,600	3,300	300	8,200	2,000	--	--	--	2,000	1,100	11,300
1r1-9	270.24	5,272	5,272	7,800	7,100	300	15,200	3,700	--	--	--	3,700	2,100	21,000
1r1-10	41.81	17,534	17,534	175,500	52,000	4,300	231,800	12,000	--	--	--	12,000	22,400	266,200
Subtotal	960.87[2/]	30,858	30,858	191,800	64,800	5,300	261,900	19,400	--	--	--	19,400	26,600	307,900
1r1(a)-3	222.82	3,637	3,637	12,400	4,200	400	17,000	4,500	--	--	--	4,500	2,300	23,800
1r1(a)-7	267.61	13,485	13,485	151,900	52,900	4,200	209,000	12,900	--	--	--	12,900	20,600	242,500
Subtotal	490.43	17,122	17,122	164,300	57,100	4,600	226,000	17,400	--	--	--	17,400	22,900	266,300

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EXHIBIT NO. 18 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Projects Not Feasible

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage				Non-Agri. Average Annual Damage					Indirect $	Total Average Annual Damage $
				Crop and Pasture[1] $	Other Agri. $	Land $	Total Agri. $	Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $		
Cimarron Unit, continued														
1r2-1	350.95	5,966	5,966	16,400	7,300	1,000	24,700	3,100	--	--	--	3,100	3,000	30,800
1r2-2	457.66	11,693	11,693	24,800	19,200	1,100	45,100	6,700	--	200[3]	--	6,900	5,500	57,500
1r2-3	235.12	Insignificant floodplain damage												
Subtotal	1,043.73	17,659	17,659	41,200	26,500	2,100	69,800	9,800	--	200	--	10,000	8,500	88,300
1v9-7	61.10	Insignificant floodplain damages												
Unit Total	6,499.02	65,639	65,639	397,300	148,400	12,000	557,700	46,600	--	200	--	46,800	58,000	662,500
Lower Arkansas Unit														
1-90	236.61	Insignificant floodplain damage												
1-91	244.40	2,825	2,825	3,000	2,700	--	5,700	4,800	--	--	--	4,800	1,300	11,800
1-92	170.05	4,600	4,600	12,300	3,500	--	15,800	6,300	--	--	--	6,300	2,500	24,600
1-93	233.11	1,111	1,111	2,200	1,000	--	3,200	1,400	--	--	--	1,400	500	5,100
1-94	41.41	581	581	1,000	600	--	1,600	1,200	--	--	--	1,200	300	3,100
1-97	199.42	8,216	8,216	43,100	12,300	500	55,900	19,100	200	2,800[4]	--	22,100	8,900	86,900
1-98	277.09	5,227	5,227	16,400	3,800	200	20,400	7,600	--	--	--	7,600	3,200	31,200
1-99	156.19	6,827	6,827	50,200	5,000	400	55,600	9,300	300	--	600[5]	10,200	7,100	72,900
1-101	146.69	7,941	7,941	85,600	5,300	700	91,600	10,100	300	--	200[6]	10,600	10,700	112,900
1-102	76.32	2,579	2,579	10,500	1,400	200	12,100	4,200	--	--	100[6]	4,300	1,900	18,300
1-105	78.63	515	515	1,700	300	--	2,000	800	--	--	--	800	300	3,100
Subtotal	1,859.92	40,422	40,422	226,000	35,900	2,000	263,900	64,800	800	2,800	900	69,300	36,700	369,900
11-1	335.82	Insignificant floodplain damages												
11-2	61.26	470	470	300	200	--	500	400	--	--	--	400	100	1,000
11-3	333.49	3,153	3,153	8,400	3,400	--	11,800	4,600	--	--	200[6]	4,800	1,900	18,500
11-4	157.97	1,484	1,484	2,700	1,500	--	4,200	3,500	--	--	--	3,500	900	8,600
11-5	416.77	14,118	14,118	13,200	13,400[7]	--	26,600	16,500	--	--	1,000[6]	17,500	5,300	49,400
Subtotal	1,305.31	19,225	19,225	24,600	18,500	--	43,100	25,000	--	--	1,200	26,200	8,200	77,500
1n-2	421.68	26,272	26,272	148,700	20,900	200	169,800	54,800	100	3,000[8]	1,900[6]	59,800	25,900	255,500
1n-3	233.88	12,201	12,201	42,800	14,700	200	57,700	20,300	200	400[9]	100[6]	21,000	8,900	87,600
1n-5	168.15	2,519	2,519	22,600	1,700	--	24,300	6,900	200	2,100[10]	--	9,200	3,800	37,300
1n-6	112.29	9,387	9,387	64,400	7,400	200	72,000	17,200	300	--	--	17,500	9,800	99,300
Subtotal	936.00	50,379	50,379	278,500	44,700	600	323,800	99,200	800	5,500	2,000	107,500	48,400	479,700

EXHIBIT NO. 18 (CONTD.)

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Projects Not Feasible

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture 1/ $	Agri.: Other Agri. $	Agri.: Land $	Agri.: Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Non-Agri.: Rail-road $	Non-Agri.: Urban $	Non-Agri.: Other $	Non-Agri.: Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Lower Arkansas Unit, continued														
lo-1	450.35	9,064	9,064	16,800	11,100	--	27,900	10,800	--	700 11/	1,100 12/	12,600	4,700	45,200
lo-2	121.92	5,425	5,425	5,100	6,500	--	11,600	3,300	100	200 13/	--	3,600	1,700	16,900
lo-3	185.77	5,845	5,845	9,700	7,500	400	17,600	6,900	100	--	--	7,000	2,800	27,400
lo-4	152.93	7,115	7,115	15,000	8,100	--	23,100	5,700	400	--	--	6,100	3,200	32,400
lo-5	62.79	1,713	1,713	2,000	1,600	200	3,800	1,500	--	--	--	1,500	600	5,900
lo-6	62.23	1,947	1,947	5,400	2,700	200	8,300	1,200	--	--	--	1,200	1,000	10,500
lo-7	275.06	18,584	18,584	56,200	14,400	2,800	73,400	17,100	300	--	100 6/	17,500	10,000	100,900
Subtotal	1,311.05	49,693	49,693	110,200	51,900	3,600	165,700	46,500	900	900	1,200	49,500	24,000	239,200
lol-1	315.06	7,013	7,013	4,800	8,800	--	13,600	3,000	--	--	--	3,000	1,800	18,400
lol-2	177.37	3,895	3,895	4,300	5,400	--	9,700	1,600	--	--	--	1,600	1,200	12,500
lol-3	47.67	1,610	1,610	3,900	1,900	100	5,900	2,400	--	--	--	2,400	900	9,200
lol-4	137.54	6,172	6,172	12,800	8,000	100	20,900	7,800	--	--	--	7,800	3,300	32,000
lol-5	131.51	1,034	1,034	4,000	1,100	--	5,100	500	--	--	--	500	600	6,200
lol-6	41.24	413	413	1,500	600	--	2,100	1,300	--	--	--	1,300	400	3,800
Subtotal	850.39	20,137	20,137	31,300	25,800	200	57,300	16,600	--	--	--	16,600	8,200	82,100
lq-1	201.26	7,784	7,784	13,100	6,600	200	19,900	7,800	300	1,000 14/	--	9,100	3,400	32,400
lq-2	332.61	4,452	4,452	1,200	2,000	--	3,200	800	--	--	--	800	400	4,400
lq-3	191.35	7,142	7,142	2,800	3,100	--	5,900	500	--	--	200 6/	700	700	7,300
lq-4	133.61	5,338	5,338	8,900	6,200	--	15,100	6,500	200	--	--	6,700	2,500	24,300
lq-5	161.92	5,476	5,476	11,000	5,900	--	16,900	8,400	--	--	--	8,400	2,900	28,200
lq-6	56.22	2,034	2,034	2,900	2,500	--	5,400	5,600	--	--	--	5,600	1,400	12,400
lq-7	28.59	Insignificant floodplain damage												
lq-8	19.60	"	"	"										
lq-9	13.08	"	"	"										
Subtotal	1,138.24	32,226	32,226	39,900	26,300	200	66,400	29,600	500	1,000	200	31,300	11,300	109,000
lql-1	336.00	4,288	4,288	2,900	1,300	500	4,700	600	--	--	--	600	600	5,900
lql-2	193.03	5,008	5,008	9,100	4,000	1,200	14,300	1,200	--	--	--	1,200	1,600	17,100
lql-3	195.93	8,515	8,515	15,300	8,600	1,000	24,900	8,000	400	1,900 15/	100 16/	10,400	4,100	39,400
lql-4	229.80	17,772	17,772	20,400	8,100	1,500	30,000	4,100	--	--	300 17/	4,400	3,600	38,000
lql-5	82.65	827	827	1,800	700	100	2,600	600	--	--	--	600	300	3,500
lql-6	62.72	1,223	1,223	4,400	800	--	5,200	1,600	--	--	400 6/	2,000	800	8,000
Subtotal	1,100.13	37,633	37,633	53,900	23,500	4,300	81,700	16,100	400	1,900	800	19,200	11,000	111,900

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Projects Not Feasible

(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1/] $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Lower Arkansas Unit, continued														
1q2-1	369.23	11,305	11,305	19,900	13,900	--	33,800	8,500	--	--	200[6/]	8,700	4,700	47,200
1q2-2	328.52	11,425	11,425	15,300	13,500	400	29,200	9,400	--	--	--	9,400	4,300	42,900
1q2-3	236.83	10,001	10,001	36,000	11,100	300	47,400	8,900	300	--	--	9,200	6,100	62,700
1q2-4	241.73	5,794	5,794	1,500	5,800	300	7,600	8,600	--	--	--	8,600	2,000	18,200
1q2-5	281.37	11,763	11,763	17,500	7,400	700	25,600	7,800	--	300[18/]	--	8,100	3,800	37,500
Subtotal	1,457.68	50,288	50,288	90,200	51,700	1,700	143,600	43,200	300	300	200	44,000	20,900	208,500
Unit Total	9,958.72	300,003	300,003	854,600	278,300	12,600	1,145,500	341,000	3,700	12,400	6,500	363,600	168,700	1,677,800
Walnut-Verdigris Unit														
1p-11	120.91	1,837	1,837	12,300	1,800	700	14,800	5,500	--	--	300[6/]	5,800	2,400	23,000
1s-5	95.20	2,352	2,352	8,100	1,500	1,300	10,900	3,200	--	--	200[6/]	3,400	1,600	15,900
1s-9	52.25	2,016	2,016	19,600	2,900	1,800	24,300	5,700	--	--	--	5,700	3,300	33,300
1s-18	127.01	7,279	7,279	53,800	3,700	3,600	61,100	8,200	--	--	300[6/]	8,500	7,400	77,000
Subtotal	274.46	11,647	11,647	81,500	8,100	6,700	96,300	17,100	--	--	500	17,600	12,300	126,200
1s1-3	86.87	Fall River Reservoir Area												
1s1-5	139.54	3,486	3,486	32,700	2,900	1,900	37,500	8,300	600	100[19/]	--	9,000	5,100	51,600
Subtotal	226.41	3,486	3,486	32,700	2,900	1,900	37,500	8,300	600	100	--	9,000	5,100	51,600
1s2-6	81.99	1,245	1,245	15,700	1,300	1,600	18,600	1,800	--	--	--	1,800	2,100	22,500
1s2-7	24.13	546	546	3,400	500	500	4,400	800	--	--	--	800	600	5,800
1s2-8	34.96	1,703	1,703	4,700	900	1,200	6,800	2,300	400	--	--	2,700	1,100	10,600
1s2-9	13.42	253	253	400	100	100	600	400	--	--	--	400	100	1,100
Subtotal	154.50	3,747	3,747	24,200	2,800	3,400	30,400	5,300	400	--	--	5,700	3,900	40,000
1-106	23.17	192	192	900	200	100	1,200	--	--	--	--	--	100	1,300
1-107	31.96	793	793	2,900	800	900	4,600	1,000	--	--	--	1,000	600	6,200
Subtotal	55.13	985	985	3,800	1,000	1,000	5,800	1,000	--	--	--	1,000	700	7,500
Unit Total	831.41	21,702	21,702	154,500	16,600	13,700	184,800	37,200	1,000	100	800	39,100	24,400	248,300

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Arkansas River Basin - Kansas
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(Price Base Adjusted Normalized)

Wshd. Iden. Code No.	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop And Pasture 1/ $	Agri.: Other Agri. $	Agri.: Land $	Agri.: Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Non-Agri.: Rail-road $	Non-Agri.: Urban $	Non-Agri.: Other $	Non-Agri.: Total Non-Agri. $	Indirect	Total Average Annual Damage $
Neosho Unit														
1t-11	95.09	394	394	2,100	500	100	2,700	1,100	--	--	--	1,100	400	4,200
1t-17	82.13	1,584	1,584	14,600	1,500	600	16,700	2,800	--	--	--	2,800	2,100	21,600
1t-28	27.03	Insignificant floodplain damage												
1t-29	34.47	532	532	500	800	--	1,300	1,200	--	--	--	1,200	300	2,800
Subtotal	238.72	2,510	2,510	17,200	2,800	700	20,700	5,100	--	--	--	5,100	2,800	28,600
Unit Total	238.72	2,510	2,510	17,200	2,800	700	20,700	5,100	--	--	--	5,100	2,800	28,600
Basin Total	20,963.23	401,257	401,257	1,477,700	479,100	39,900	1,996,700	433,200	4,900	12,700	7,300	458,100	263,200	2,718,000

1/ Crop yields projected to year 1980
2/ Total drainage area - 1,830 square miles, only 960.87 contribute to runoff
3/ City of Meade
4/ Wichita suburb "The Dell"
5/ Oil field and Wellington City Park
6/ Oil field
7/ Includes $100 to Quivira National Wildlife Refuge
8/ City of McPherson
9/ City of Moundridge
10/ City of Halstead
11/ City of Pratt
12/ Oil field $900; fish hatchery $200
13/ City of Kingman
14/ City of Wilmore
15/ City of Medicine Lodge
16/ Sand pit
17/ Oil field $200; booster station $100
18/ City of Caldwell
19/ City of Fredonia

Arkansas River Basin - Kansas
Exhibit 18 - Average Annual Damages
Summary All Projects

(Price Base Adjusted Normalized)

Projects	Drainage Area Sq.Mi.	Area with Problem Ac.	Area Needing Project Action Ac.	Agri. Average Annual Damage: Crop and Pasture[1] $	Other Agri. $	Land $	Total Agri. $	Non-Agri. Average Annual Damage: Road and Bridge $	Rail-road $	Urban $	Other $	Total Non-Agri. $	Indirect $	Total Average Annual Damage $
Upper Arkansas Unit														
Authorized for Planning[2]	1,623.56	38,968	38,968	307,800	36,100	43,700	387,600	14,400	2,000	51,200	100	67,700	48,400	503,700
Early Action	5,135.17	199,026	199,026	1,087,400	202,400	16,700	1,306,500	105,400	11,100	--	200	116,700	147,300	1,570,500
Long Range	128.76	1,519	1,519	14,100	8,400	300	22,800	600	--	--	--	600	2,400	25,800
Not Feasible	3,435.36	11,403	11,403	54,100	33,000	900	88,000	3,300	200	--	--	3,500	9,300	100,800
Total Unit	10,322.85	250,916	250,916	1,463,400	279,900	61,600	1,804,900	123,700	13,300	51,200	300	188,500	207,400	2,200,800
Cimarron Unit														
Authorized for Planning[2]	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Early Action	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Long Range	288.96	2,759	2,759	9,700	3,400	300	13,400	2,000	--	--	--	2,000	1,500	16,900
Not Feasible	6,499.02	65,639	65,639	397,300	148,400	12,000	557,700	46,600	--	200	--	46,800	58,000	662,500
Total Unit	6,787.98	68,398	68,398	407,000	151,800	12,300	571,100	48,600	--	200	--	48,800	59,500	679,400
Lower Arkansas Unit														
Authorized for Planning[2]	200.55	15,016	15,016	85,800	14,300	12,900	113,000	26,400	2,600	11,900	--	40,900	15,700	169,600
Early Action	1,384.48	53,548	53,548	362,000	51,200	4,800	418,000	117,300	3,700	4,400	8,300	133,700	61,900	613,600
Long Range	56.41	1,954	1,954	7,600	900	1,200	9,700	5,300	--	--	100	5,400	1,800	16,900
Not Feasible	9,958.72	300,003	300,003	854,600	278,300	12,600	1,145,500	341,000	3,700	12,400	6,500	363,600	168,700	1,677,800
Total Unit	11,600.16	370,521	370,521	1,310,000	344,700	31,500	1,686,200	490,000	10,000	28,700	14,900	543,600	248,100	2,477,900
Walnut-Verdigris Unit														
Authorized for Planning[2]	3,751.12	154,629	154,629	2,025,900	294,100	459,100	2,779,100	282,300	21,700	20,100	2,600	326,700	292,100	3,397,900
Early Action	173.87	8,615	8,615	96,000	8,100	4,600	108,700	16,900	500	9,600	200	27,200	14,900	150,800
Long Range	2,083.07	77,902	77,902	665,400	71,000	81,100	817,500	127,400	5,700	400	7,600	141,100	102,900	1,061,500
Not Feasible	831.41	21,702	21,702	154,500	16,600	13,700	184,800	37,200	1,000	100	800	39,100	24,400	248,300
Total Unit	6,839.47	262,848	262,848	2,941,800	389,800	558,500	3,890,100	463,800	28,900	30,200	11,200	534,100	434,300	4,858,500
Neosho Unit														
Authorized for Planning[2]	151.38	7,597	7,597	81,000	6,500	23,600	111,100	7,100	--	--	--	7,100	11,600	129,800
Early Action	3,254.22	190,541	190,541	2,651,100	179,400	137,800	2,968,300	380,400	28,200	2,600	6,900	418,100	358,700	3,745,100
Long Range	2,670.43	91,889	91,889	1,065,600	83,900	57,000	1,206,500	181,900	4,000	3,000	2,500	191,400	149,300	1,547,200
Not Feasible	238.72	2,510	2,510	17,200	2,800	700	20,700	5,100	--	--	--	5,100	2,800	28,600
Total Unit	6,314.75	292,537	292,537	3,814,900	272,600	219,100	4,306,600	574,500	32,200	5,600	9,400	621,700	522,400	5,450,700
Total All Units														
Authorized for Planning[2]	5,726.61	216,210	216,210	2,500,500	351,000	539,300	3,390,800	330,200	26,300	83,200	2,700	442,400	367,800	4,201,000
Early Action	9,947.74	451,730	451,730	4,196,500	441,100	163,900	4,801,500	620,000	43,500	16,600	15,600	695,700	582,800	6,080,000
Long Range	5,227.63	176,023	176,023	1,762,400	167,600	139,900	2,069,900	317,200	9,700	3,400	10,200	340,500	257,900	2,668,300
Not Feasible	20,963.23	401,257	401,257	1,477,700	479,100	39,900	1,996,700	433,200	4,900	12,700	7,300	458,100	263,200	2,718,000
GRAND TOTAL	41,865.21	1,245,220	1,245,220	9,937,100	1,438,800	883,000	12,258,900	1,700,600	84,400	115,900	35,800	1,936,700	1,471,700	15,667,300

1/ Crop yield projected to year 1980

2/ Includes completed projects and those authorized for construction

EXHIBIT NO. 18 (CONTD.)

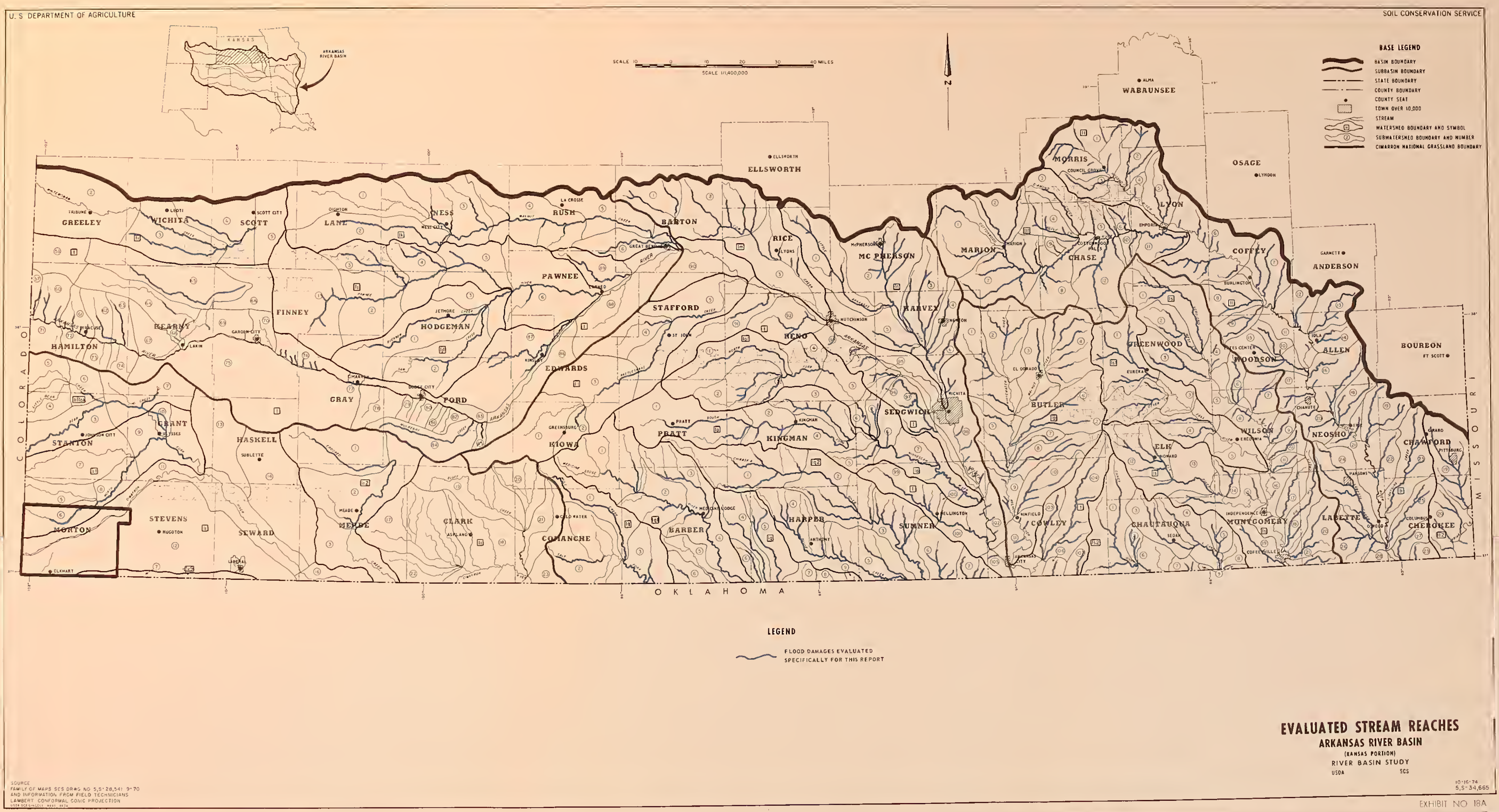


EXHIBIT NO 18A

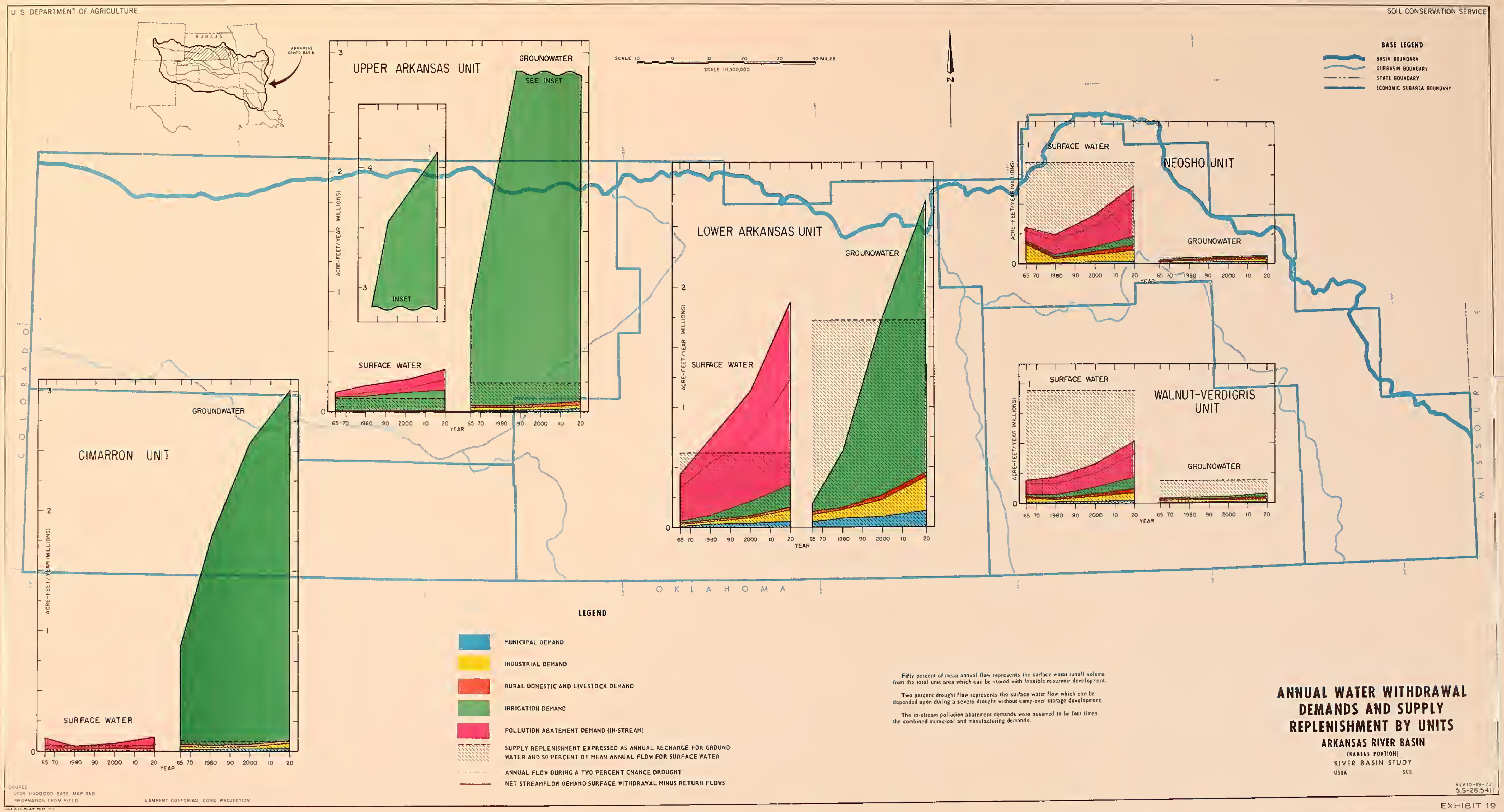

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS
ARKANSAS RIVER BASIN
SCALE 10 0 10 20 30 40 MILES
SCALE 1/1,400,000
N
BASE LEGEND
BASIN BOUNDARY
SUBBASIN BOUNDARY
STATE BOUNDARY
ECONOMIC SUBAREA BOUNDARY
UPPER ARKANSAS UNIT
GROUNDWATER
SEE INSET
INSET
SURFACE WATER
ACRE-FEET/YEAR (MILLIONS)
YEAR
LOWER ARKANSAS UNIT
NEOSHO UNIT
WALNUT-VERDIGRIS UNIT
CIMARRON UNIT
COLORADO
OKLAHOMA
MISSOURI
LEGEND
MUNICIPAL DEMAND
INDUSTRIAL DEMAND
RURAL DOMESTIC AND LIVESTOCK DEMAND
IRRIGATION DEMAND
POLLUTION ABATEMENT DEMAND (IN-STREAM)
SUPPLY REPLENISHMENT EXPRESSED AS ANNUAL RECHARGE FOR GROUND WATER AND 50 PERCENT OF MEAN ANNUAL FLOW FOR SURFACE WATER
ANNUAL FLOW DURING A TWO PERCENT CHANCE DROUGHT
NET STREAMFLOW DEMAND-SURFACE WITHDRAWAL MINUS RETURN FLOWS
Fifty percent of mean annual flow represents the surface water runoff volume from the total unit area which can be stored with feasible reservoir development.
Two percent drought flow represents the surface water flow which can be depended upon during a severe drought without carry-over storage development.
The in-stream pollution abatement demands were assumed to be four times the combined municipal and manufacturing demands.
ANNUAL WATER WITHDRAWAL
DEMANDS AND SUPPLY
REPLENISHMENT BY UNITS
ARKANSAS RIVER BASIN
(KANSAS PORTION)
RIVER BASIN STUDY
USDA SCS
SOURCE
USGS 1/500,000 BASE MAP AND
INFORMATION FROM FIELD
LAMBERT CONFORMAL CONIC PROJECTION
REV 10-19-72
5,S-28,541

EXHIBIT 19

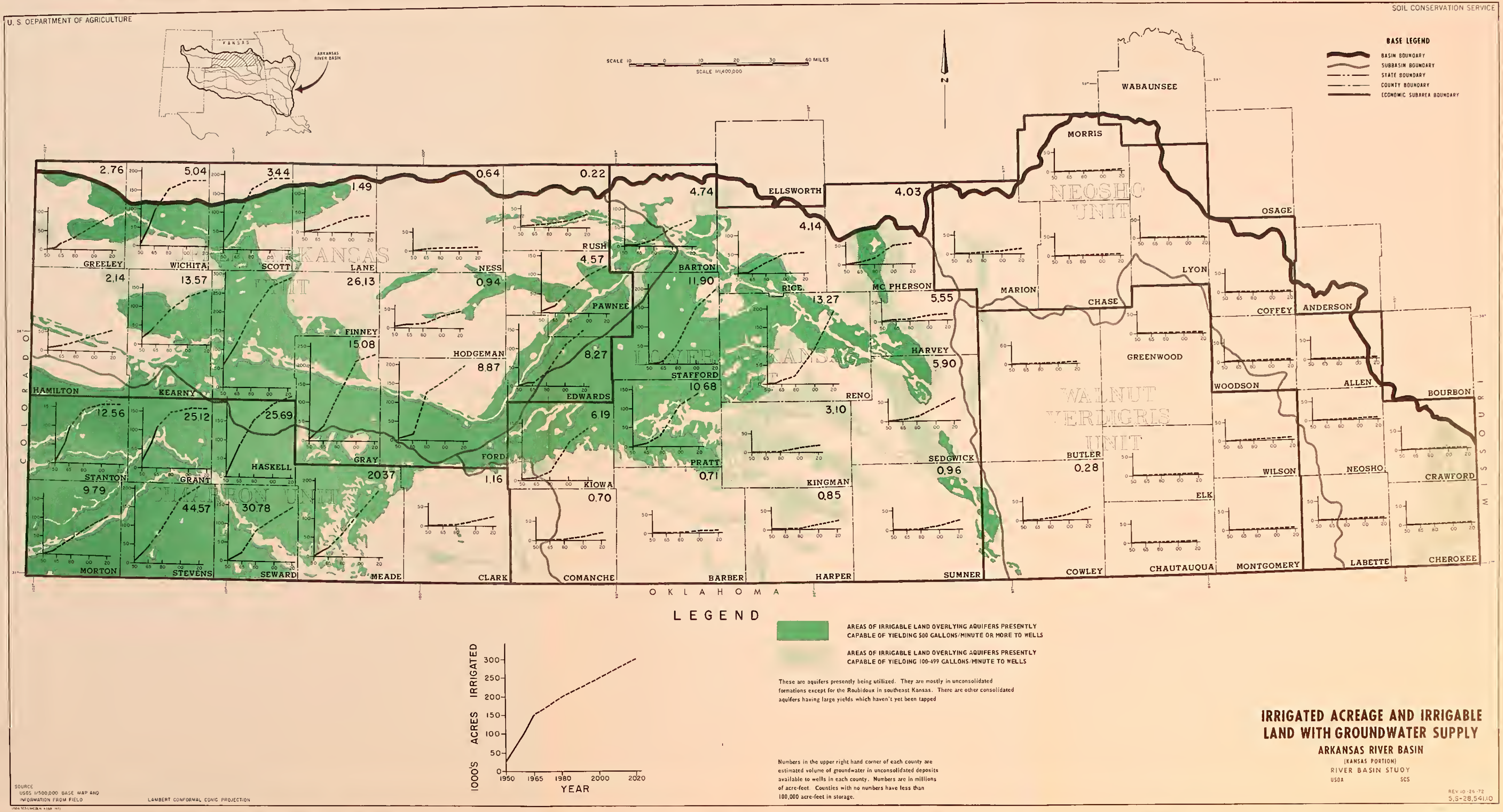
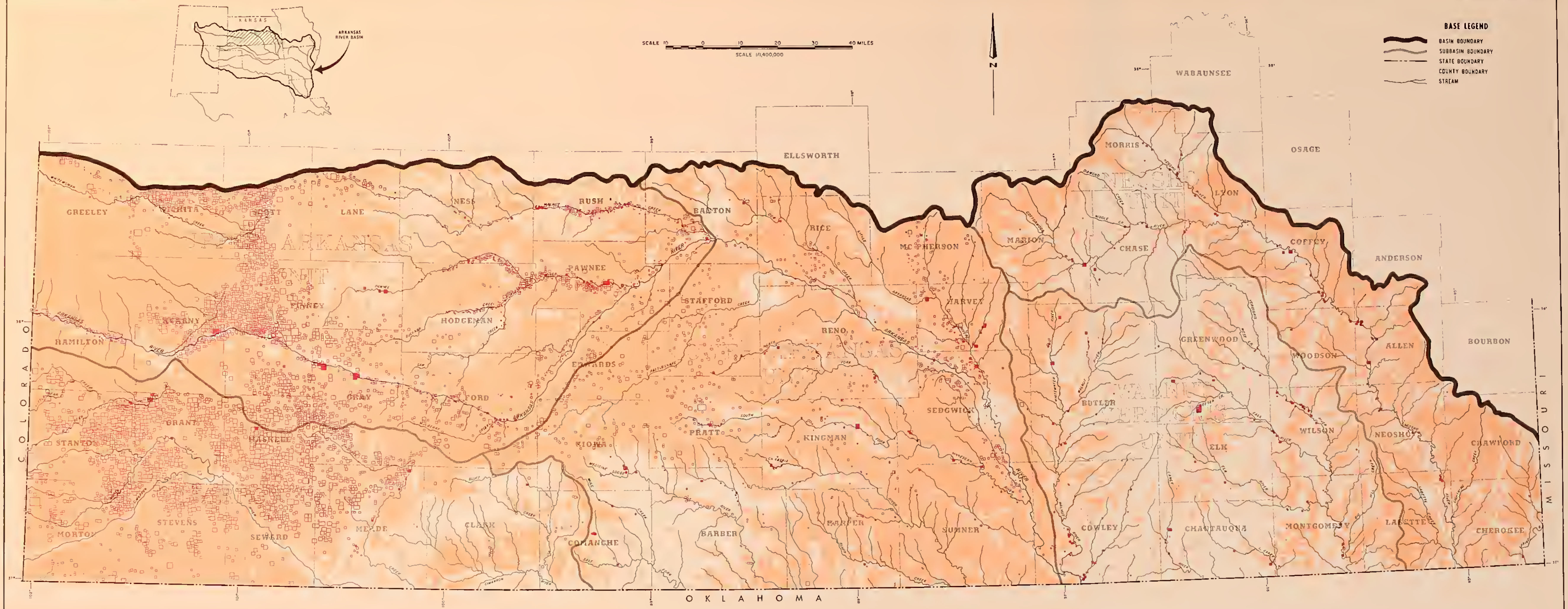


EXHIBIT NO. 20

U S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



LEGEND

LAND SUITABLE FOR IRRIGATION 1966
(WITHOUT CONSIDERATION OF AVAILABLE WATER)

☐ IRRIGATION WATER RIGHT - GROUND WATER SOURCE

■ IRRIGATION WATER RIGHT - SURFACE WATER SOURCE

Note: Smallest squares represent 40 acres.

Actual shape of tracts has been generalized into squares or rectangles to simplify drafting.

LAND SUITABLE FOR IRRIGATION AND LOCATION OF TRACTS HAVING WATER RIGHTS FOR IRRIGATION

ARKANSAS RIVER BASIN

(KANSAS PORTION)

RIVER BASIN STUDY

USDA SCS

SOURCE
USGS 1/500,000 BASE MAP, WATER RIGHTS INFORMATION FROM THE DIVISION OF WATER RESOURCES, KANSAS STATE BOARD OF AGRICULTURE, AND INFORMATION FROM FIELD.

LAMBERT CONFORMAL CONIC PROJECTION

5-2-71
5,S-28,541.15

EXHIBIT NO. 21

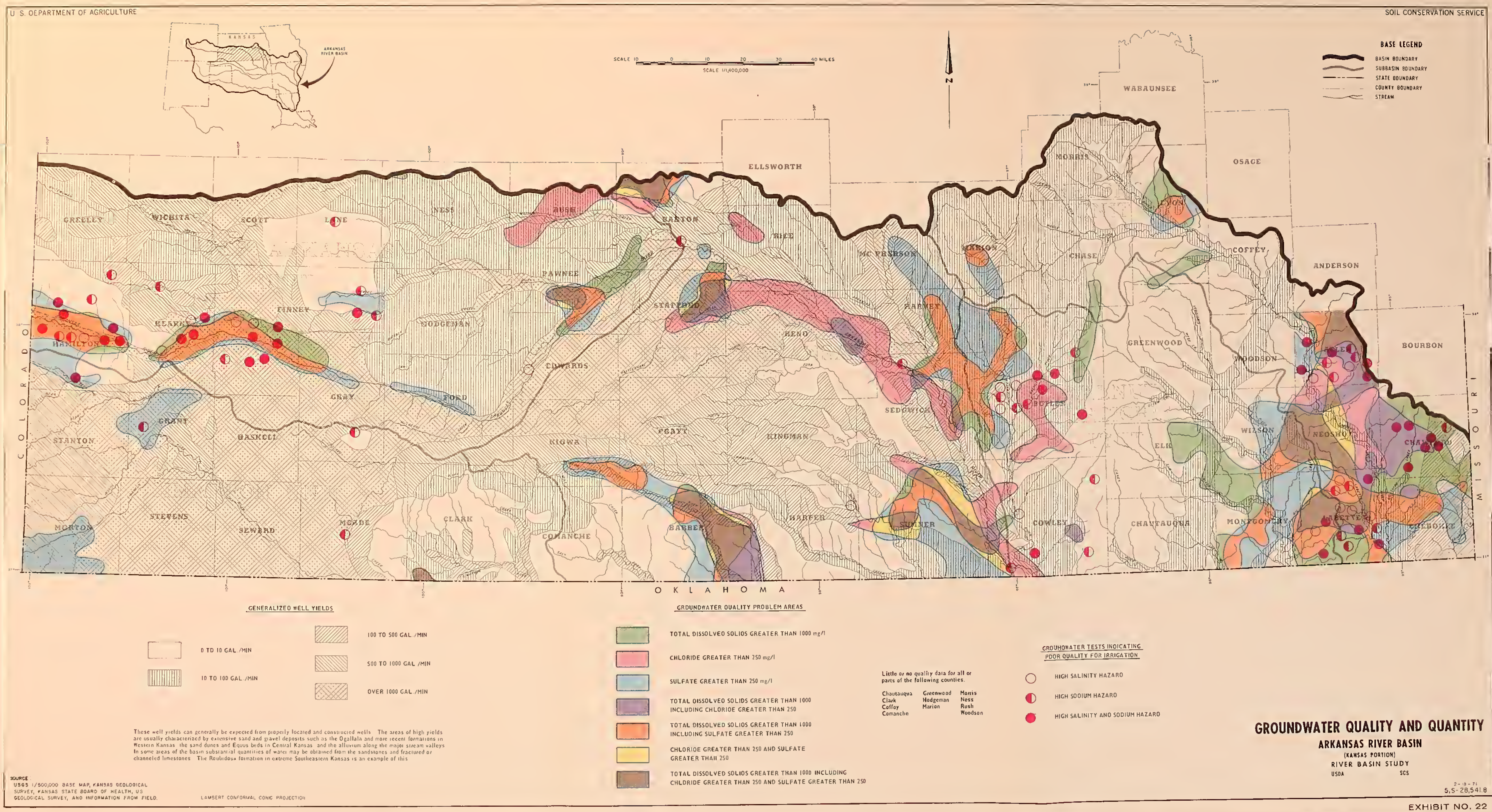
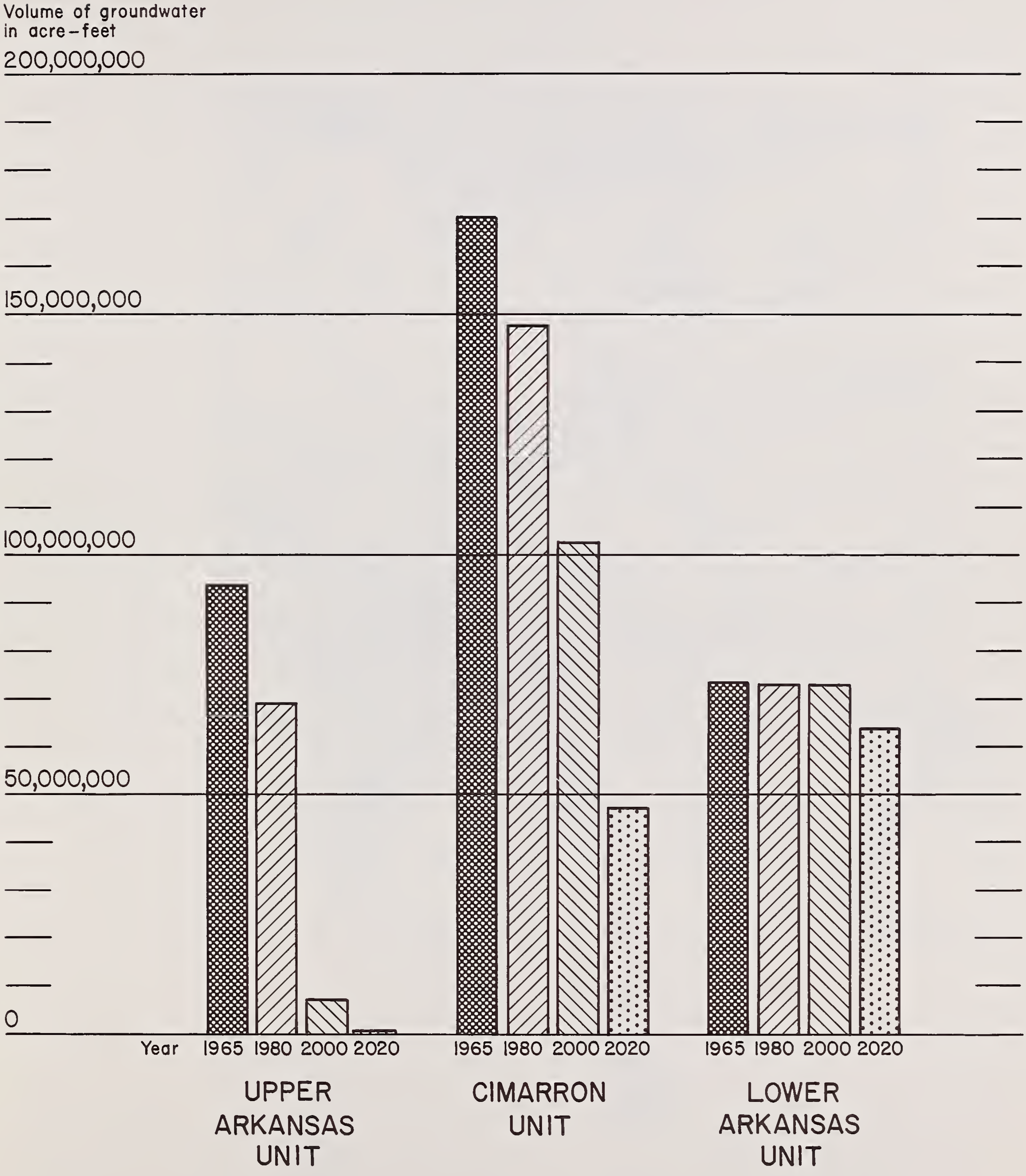


EXHIBIT NO. 22

ESTIMATED CHANGES IN GROUNDWATER STORAGE AVAILABLE TO WELLS



NOTE: GROUNDWATER STORAGE IN THE WALNUT, VERDIGRIS, & NEOSHO UNITS IS NEGLIGIBLE.

SOURCE: DIVISION OF WATER RESOURCES, KANSAS BOARD OF AGRICULTURE, KANSAS GEOLOGICAL SURVEY, AND UNITED STATES GEOLOGICAL SURVEY.

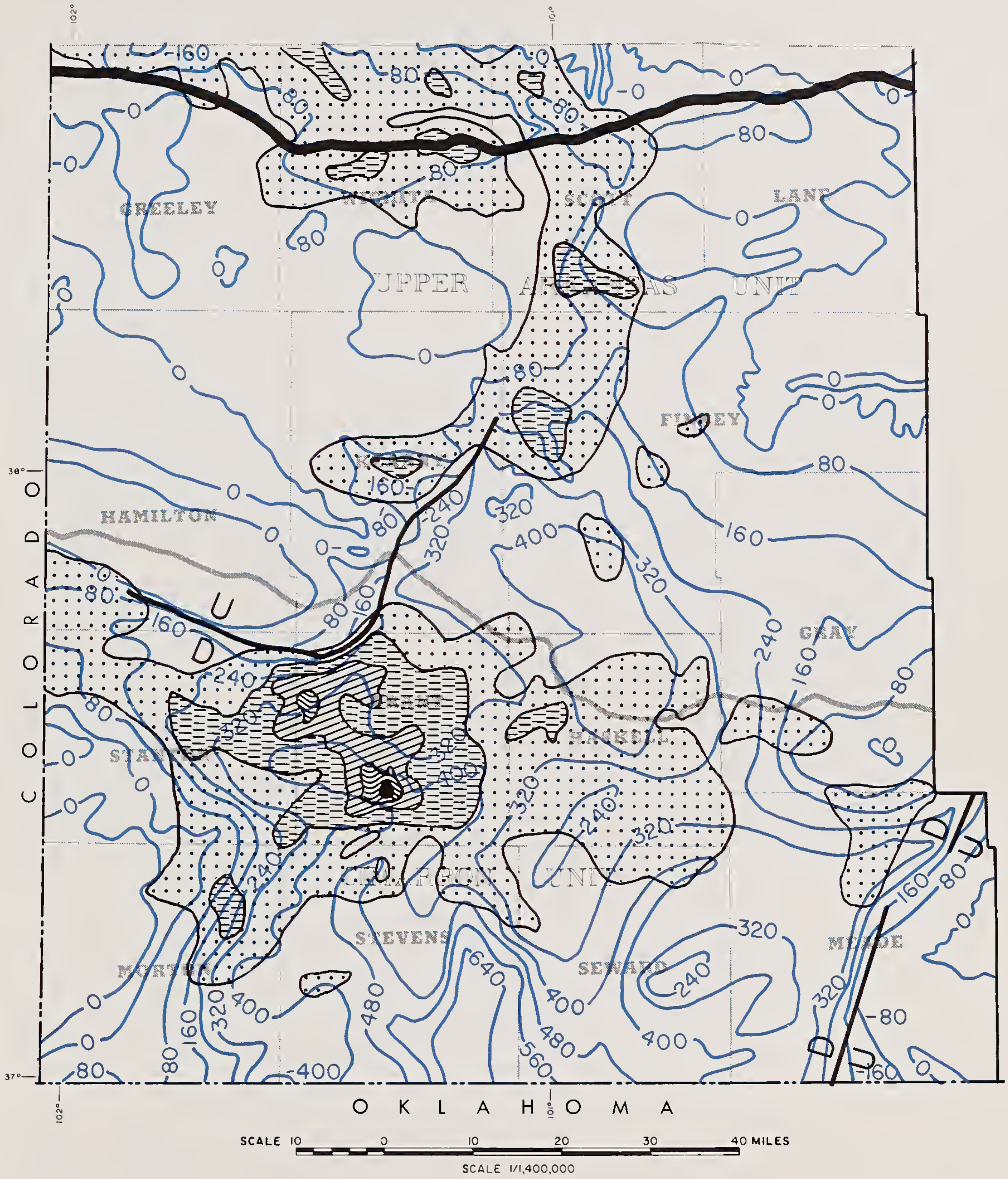
EXHIBIT 23

10-30-72
5,L-30,835

USDA-SCS-LINCOLN, NEBR. 1972

EXHIBIT 24

WATER LEVEL DECLINE AND SATURATED THICKNESS OF THE PRINCIPAL AQUIFER-SOUTHWEST KANSAS



LEGEND

LESS THAN 10 FEET DECLINE

10-30 FEET DECLINE

30-50 FEET DECLINE

50-70 FEET DECLINE

70-90 FEET DECLINE

GREATER THAN 90 FEET DECLINE

—80— SATURATED THICKNESS (FEET) OF THE PRINCIPAL AQUIFER - 1967

U/D FAULT U - UPTHROWN SIDE D - DOWNTHROWN SIDE

INFORMATION BASED ON 1940-1970 PERIOD. THE UPPER TWO-THIRDS OF GREELEY, WICHITA AND SCOTT COUNTIES BASED ON 1950-1970 PERIOD.

SOURCE: Division of Water Resources, Kansas Board of Agriculture, Kensas Geological Survey; and United States Geological Survey

USDA-SCS-LINCOLN, NEBR 1972

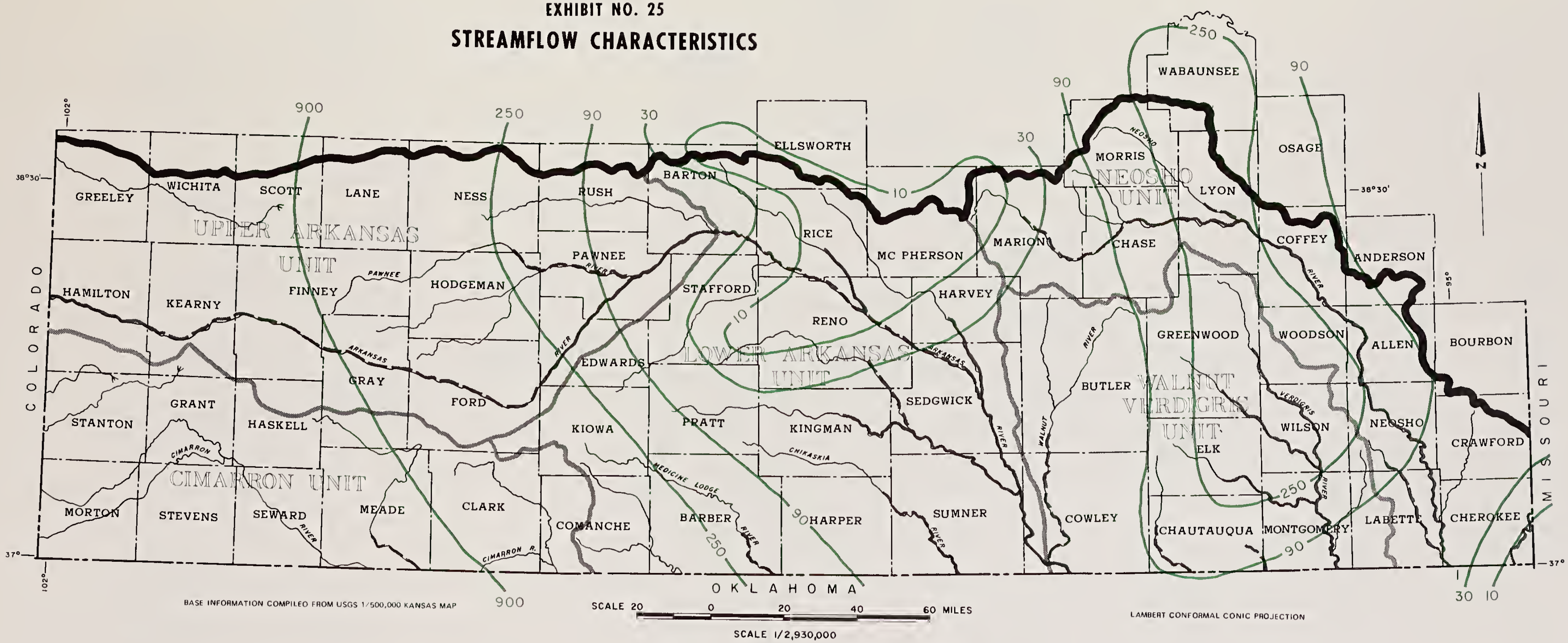
LAMBERT CONFORMAL CONIC PROJECTION
BASE INFORMATION COMPILED FROM USGS 1/500,000 KANSAS MAP

EXHIBIT NO. 24

3-12-71 REV.
5,0-28,616.5

EXHIBIT NO. 25

STREAMFLOW CHARACTERISTICS



LEGEND

250	DRAINAGE AREA SIZE (SQ.MILES) REQUIRED TO CHANGE A STREAM FROM EPHEMERAL TO INTERMITTENT
	PERENNIAL STREAM (discharge of 0.1 cfs or greater, 99% of the time)
	INTERMITTENT STREAM (discharge of 0.1 cfs or greater, 85 to 99% of the time)
	EPHEMERAL STREAM (discharge of 0.1 cfs 85% of the time or less)

USDA-SCS-LINCOLN, NEBR. 1972

12-9-70
5,0-28,616.3

Exhibit No. 26

ANNUAL WATER DEMANDS BY COUNTIES (ACRE-FEET PER YEAR)

UPPER ARKANSAS UNIT

SCOTT COUNTY

	1965	1980	2000	2020
Irrigation	165,000	393,400	462,500	467,200
Livestock	680	1,468	3,107	4,718
Rural Domestic	288	474	414	338
Municipal	1,054	483	1,358	2,095
Industrial	595	593	1,025	1,742

LANE COUNTY

	1965	1980	2000	2020
Irrigation	12,200	42,900	99,800	110,700
Livestock	643	833	1,441	2,188
Rural Domestic	230	254	209	175
Municipal	380	337	493	802
Industrial	14	31	52	84

WICHITA COUNTY

	1965	1980	2000	2020
Irrigation	183,000	369,600	426,000	430,300
Livestock	368	1,002	2,764	4,196
Rural Domestic	239	445	464	417
Municipal	506	273	299	500
Industrial	144	2	2	3

NESS COUNTY

	1965	1980	2000	2020
Irrigation	9,400	17,900	22,100	25,500
Livestock	938	1,003	1,409	2,139
Rural Domestic	378	296	217	182
Municipal	643	705	975	1,537
Industrial	187	476	1,077	2,140

GREELEY COUNTY

	1965	1980	2000	2020
Irrigation	26,000	83,400	155,800	231,200
Livestock	322	700	1,631	2,476
Rural Domestic	174	195	259	222
Municipal	314	264	295	503
Industrial	24	0	0	0

RUSH COUNTY

	1965	1980	2000	2020
Irrigation	12,400	19,100	33,800	61,000
Livestock	583	780	1,200	1,822
Rural Domestic	310	247	183	151
Municipal	415	916	1,195	1,893
Industrial	196	850	1,414	2,869

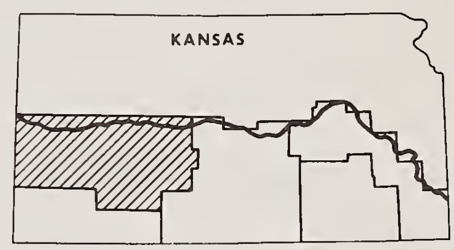
HAMILTON COUNTY

	1965	1980	2000	2020
Irrigation	31,200	57,200	104,700	142,600
Livestock	320	412	638	968
Rural Domestic	220	157	176	153
Municipal	541	464	447	669
Industrial	50	31	158	446

PAWNEE COUNTY

	1965	1980	2000	2020
Irrigation	32,000	102,200	177,900	229,000
Livestock	621	1,053	1,925	2,924
Rural Domestic	437	341	288	254
Municipal	1,099	1,833	2,383	3,841
Industrial	375	622	1,415	3,105

NOTE:
MUNICIPAL EXCLUDES INDUSTRIAL.
INDUSTRIAL INCLUDES MINING, MANUFACTURING, AND UTILITIES.



KEARNY COUNTY

	1965	1980	2000	2020
Irrigation	85,000	200,300	292,100	368,900
Livestock	350	600	965	1,464
Rural Domestic	214	217	251	239
Municipal	468	449	555	946
Industrial	476	728	760	1,491

EDWARDS COUNTY

	1965	1980	2000	2020
Irrigation	15,300	60,600	195,700	277,100
Livestock	479	547	690	1,047
Rural Domestic	259	159	155	135
Municipal	653	808	1,017	1,519
Industrial	174	258	426	892

FINNEY COUNTY

	1965	1980	2000	2020
Irrigation	212,000	465,000	657,000	674,000
Livestock	892	2,163	4,032	6,121
Rural Domestic	691	561	680	617
Municipal	2,858	4,226	5,076	7,442
Industrial	11,492	2,825	4,126	8,068

HODGEMAN COUNTY

	1965	1980	2000	2020
Irrigation	18,000	33,600	81,000	112,100
Livestock	912	1,037	1,393	2,115
Rural Domestic	285	209	195	161
Municipal	302	236	294	496
Industrial	271	149	156	321

GRAY COUNTY

	1965	1980	2000	2020
Irrigation	76,000	269,200	527,900	586,100
Livestock	595	919	1,370	2,080
Rural Domestic	317	252	254	211
Municipal	518	739	999	1,633
Industrial	5	28	60	109

FORD COUNTY

	1965	1980	2000	2020
Irrigation	30,600	179,500	392,800	504,600
Livestock	1,269	2,339	3,395	5,155
Rural Domestic	968	446	425	365
Municipal	3,396	5,278	6,693	9,788
Industrial	7,665	2,564	4,352	8,642

EXHIBIT NO. 26 12-22-70 5,0-28616.7

USDA-SCS-LINCOLN, NEBR. 1972

Exhibit No. 26

ANNUAL WATER DEMANDS BY COUNTIES (ACRE-FEET PER YEAR)

CIMARRON UNIT

GRANT COUNTY

	1965	1980	2000	2020
Irrigation	200,000	357,700	389,500	393,400
Livestock	223	463	785	1,192
Rural Domestic	384	346	353	310
Municipal	773	1,312	1,392	1,996
Industrial	4,486	1,239	2,704	5,714

HASKELL COUNTY

	1965	1980	2000	2020
Irrigation	179,000	369,600	486,800	541,000
Livestock	401	778	1,684	2,557
Rural Domestic	214	418	429	355
Municipal	624	478	685	1,140
Industrial	1,227	1,108	1,896	4,030

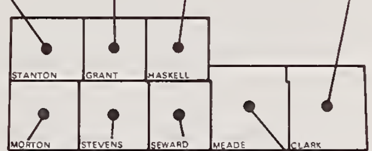
STANTON COUNTY

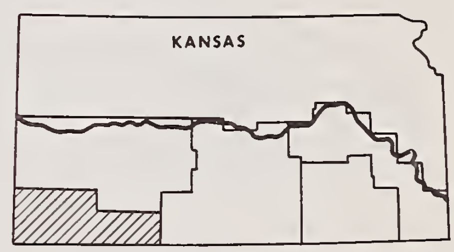
	1965	1980	2000	2020
Irrigation	197,000	345,800	389,500	393,500
Livestock	311	582	1,285	1,951
Rural Domestic	194	431	473	429
Municipal	474	150	263	543
Industrial	13	9	14	39

CLARK COUNTY

	1965	1980	2000	2020
Irrigation	1,980	7,200	34,400	61,200
Livestock	859	1,116	1,452	2,205
Rural Domestic	195	383	403	424
Municipal	555	465	673	1,125
Industrial	76	48	111	234

NOTE:
MUNICIPAL EXCLUDES INDUSTRIAL.
INDUSTRIAL INCLUDES MINING, MANUFACTURING, AND UTILITIES.





MORTON COUNTY

	1965	1980	2000	2020
Irrigation	50,000	114,400	197,200	270,500
Livestock	215	300	681	1,034
Rural Domestic	195	249	195	163
Municipal	240	845	1,082	1,655
Industrial	172	1,020	1,409	2,931

MEADE COUNTY

	1965	1980	2000	2020
Irrigation	41,300	139,100	314,300	458,700
Livestock	750	1,170	1,939	2,944
Rural Domestic	323	471	416	360
Municipal	836	1,010	1,297	2,081
Industrial	104	664	1,518	3,049

STEVENS COUNTY

	1965	1980	2000	2020
Irrigation	80,000	224,100	433,300	516,400
Livestock	220	348	603	916
Rural Domestic	232	410	266	204
Municipal	969	966	1,292	2,031
Industrial	42	376	405	839

SEWARD COUNTY

	1965	1980	2000	2020
Irrigation	45,600	202,700	292,100	363,900
Livestock	348	356	410	622
Rural Domestic	406	229	202	164
Municipal	2,689	5,091	6,812	9,540
Industrial	26,783	6,911	15,724	31,756

1-6-71
5,0-28616.9

USDA-SCS-LINCOLN, NEBR. 1972

Exhibit No. 26

ANNUAL WATER DEMANDS BY COUNTIES (ACRE-FEET PER YEAR)

LOWER ARKANSAS UNIT

RICE COUNTY

	1965	1980	2000	2020
Irrigation	11,700	84,400	162,600	171,900
Livestock	763	1,238	2,093	3,178
Rural Oomestic	432	236	235	207
Municipal	1,777	1,973	2,050	3,065
Industrial	3,865	2,909	3,105	6,303

RENO COUNTY

	1965	1980	2000	2020
Irrigation	4,600	43,700	281,500	600,100
Livestock	1,545	2,030	2,999	4,553
Rural Oomestic	1,814	470	456	455
Municipal	5,301	11,723	14,865	21,485
Industrial	18,593	11,523	25,367	56,564

BARTON COUNTY

	1965	1980	2000	2020
Irrigation	10,900	26,800	88,900	129,300
Livestock	896	1,593	3,290	4,995
Rural Oomestic	893	294	353	329
Municipal	3,547	6,067	7,002	9,779
Industrial	3,033	10,449	13,476	27,961

McPHERSON COUNTY

	1965	1980	2000	2020
Irrigation	8,400	54,300	156,400	171,900
Livestock	1,511	1,811	2,682	4,073
Rural Oomestic	763	289	277	252
Municipal	3,368	3,682	4,462	6,376
Industrial	2,404	800	1,372	3,108

STAFFORO COUNTY

	1965	1980	2000	2020
Irrigation	13,600	86,800	266,800	362,000
Livestock	681	1,062	1,649	2,503
Rural Oomestic	346	256	246	239
Municipal	907	997	1,273	2,118
Industrial	244	780	946	1,881

HARVEY COUNTY

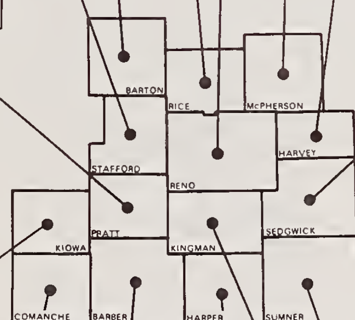
	1965	1980	2000	2020
Irrigation	3,600	15,100	36,000	60,000
Livestock	1,006	1,245	1,696	2,575
Rural Oomestic	530	189	178	163
Municipal	3,062	4,611	6,444	8,851
Industrial	724	2,177	4,711	9,323

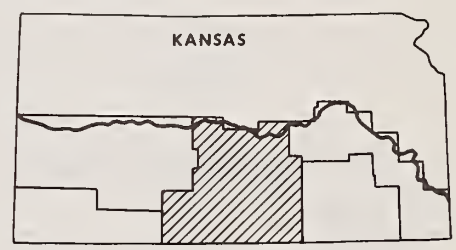
PRATT COUNTY

	1965	1980	2000	2020
Irrigation	12,000	50,200	195,700	258,600
Livestock	556	1,313	3,208	4,871
Rural Oomestic	380	247	303	264
Municipal	2,015	2,056	2,214	3,311
Industrial	1,182	1,144	2,580	5,337

SEOGWICK COUNTY

	1965	1980	2000	2020
Irrigation	4,000	34,700	109,500	184,400
Livestock	1,295	1,459	2,438	3,702
Rural Oomestic	3,465	298	310	295
Municipal	32,129	65,318	81,129	116,210
Industrial	33,164	65,078	136,045	265,883





NOTE:
MUNICIPAL EXCLUDES INDUSTRIAL.
INDUSTRIAL INCLUDES MINING, MANUFACTURING, AND UTILITIES.

KIOWA COUNTY

	1965	1980	2000	2020
Irrigation	9,500	38,100	177,900	251,200
Livestock	516	610	822	1,248
Rural Oomestic	252	130	119	108
Municipal	658	819	1,036	1,564
Industrial	277	373	851	1,711

SUMNER COUNTY

	1965	1980	2000	2020
Irrigation	800	6,900	32,800	73,400
Livestock	1,136	1,576	2,278	3,458
Rural Oomestic	854	373	343	317
Municipal	2,691	3,802	5,325	8,015
Industrial	712	1,599	3,309	6,882

COMANCHE COUNTY

	1965	1980	2000	2020
Irrigation	2,000	7,800	16,000	33,200
Livestock	843	1,053	1,560	2,368
Rural Domestic	162	184	178	160
Municipal	372	357	350	581
Industrial	77	32	39	88

KINGMAN COUNTY

	1965	1980	2000	2020
Irrigation	1,540	11,400	37,500	62,500
Livestock	1,088	1,359	1,712	2,600
Rural Oomestic	562	249	215	193
Municipal	690	1,174	1,141	1,611
Industrial	135	1,080	2,464	4,926

BARBER COUNTY

	1965	1980	2000	2020
Irrigation	1,150	2,100	9,600	21,200
Livestock	1,175	1,574	2,256	3,426
Rural Domestic	334	256	245	226
Municipal	992	1,165	1,162	1,746
Industrial	344	1,900	4,293	8,554

HARPER COUNTY

	1965	1980	2000	2020
Irrigation	730	12,100	38,200	65,600
Livestock	865	1,146	1,742	2,645
Rural Oomestic	408	257	243	219
Municipal	908	1,211	1,380	2,140
Industrial	545	720	1,643	3,410

Exhibit No. 26

ANNUAL WATER DEMANDS BY COUNTIES (ACRE-FEET PER YEAR)

WALNUT VERDIGRIS UNIT

GREENWOOD COUNTY

	1965	1980	2000	2020
Irrigation	360	3,000	3,800	4,400
Livestock	1,358	2,366	3,661	5,559
Rural Domestic	306	237	263	271
Municipal	666	843	710	1,014
Industrial	486	1,428	1,596	2,963

ELK COUNTY

	1965	1980	2000	2020
Irrigation	200	1,200	2,300	4,700
Livestock	873	1,365	1,980	3,006
Rural Domestic	163	139	150	155
Municipal	263	306	221	323
Industrial	485	25	30	55

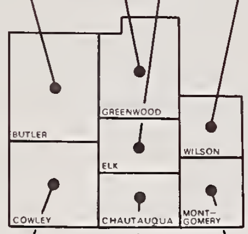
BUTLER COUNTY

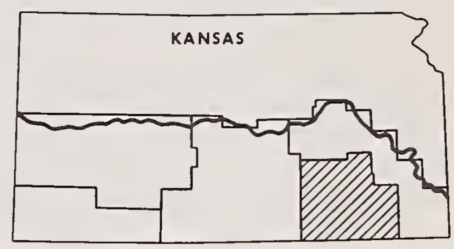
	1965	1980	2000	2020
Irrigation	500	5,700	10,600	15,600
Livestock	1,883	3,897	6,818	10,351
Rural Domestic	1,209	470	555	555
Municipal	3,017	5,276	6,842	10,045
Industrial	8,739	10,511	24,294	35,414

WILSON COUNTY

	1965	1980	2000	2020
Irrigation	450	2,500	3,900	9,200
Livestock	749	1,116	2,014	3,058
Rural Domestic	371	156	173	175
Municipal	1,183	1,232	1,275	1,745
Industrial	2,656	2,482	4,675	9,168

NOTE:
MUNICIPAL EXCLUDES INDUSTRIAL.
INDUSTRIAL INCLUDES MINING, MANUFACTURING, AND UTILITIES.





COWLEY COUNTY

	1965	1980	2000	2020
Irrigation	2,400	19,900	51,600	100,000
Livestock	1,512	2,434	3,712	5,636
Rural Domestic	826	357	391	404
Municipal	3,931	5,016	5,636	8,161
Industrial	42,419	5,661	10,528	19,985

MONTGOMERY COUNTY

	1965	1980	2000	2020
Irrigation	180	1,300	2,000	5,900
Livestock	944	1,490	2,252	3,419
Rural Domestic	710	165	166	163
Municipal	3,662	4,770	5,266	7,509
Industrial	5,253	8,845	17,029	33,372

CHAUTAUQUA COUNTY

	1965	1980	2000	2020
Irrigation	500	2,700	3,400	4,100
Livestock	815	1,195	1,754	2,663
Rural Domestic	182	119	127	130
Municipal	373	453	406	588
Industrial	25	824	1,438	2,866

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USDA-SCS-LINCOLN NEBR. 1972

Exhibit No. 26

ANNUAL WATER DEMANDS BY COUNTIES (ACRE-FEET PER YEAR)

NEOSHO UNIT

MORRIS COUNTY	1965	1980	2000	2020
Irrigation	180	1,200	2,800	6,600
Livestock	1,135	1,769	2,614	3,968
Rural Domestic	286	189	199	196
Municipal	303	615	693	1,031
Industrial	232	220	434	753

LYON COUNTY	1965	1980	2000	2020
Irrigation	200	5,100	10,600	21,900
Livestock	1,390	2,991	5,470	8,306
Rural Domestic	462	282	316	305
Municipal	2,635	3,576	4,323	6,291
Industrial	1,493	3,723	6,614	12,806

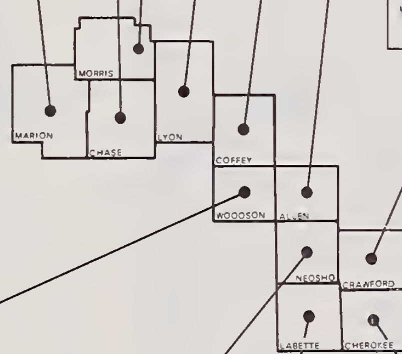
CHASE COUNTY	1965	1980	2000	2020
Irrigation	300	1,600	2,500	3,800
Livestock	811	2,745	5,180	7,865
Rural Domestic	167	205	242	214
Municipal	185	255	208	309
Industrial	153	95	111	4,649

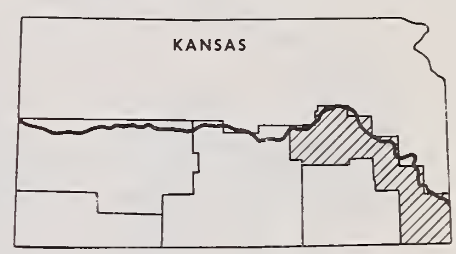
COFFEY COUNTY	1965	1980	2000	2020
Irrigation	230	700	1,300	4,000
Livestock	1,118	1,666	2,624	3,984
Rural Domestic	289	149	159	154
Municipal	356	557	559	846
Industrial	47	7,442	12,353	11,578

MARION COUNTY	1965	1980	2000	2020
Irrigation	360	5,700	21,000	46,900
Livestock	1,607	2,167	3,154	4,789
Rural Domestic	584	325	304	302
Municipal	892	1,598	1,682	2,471
Industrial	257	5,389	6,025	10,992

ALLEN COUNTY	1965	1980	2000	2020
Irrigation	400	1,900	2,800	4,700
Livestock	942	1,109	1,743	2,646
Rural Domestic	355	103	104	100
Municipal	1,128	1,467	1,753	2,569
Industrial	1,966	1,989	3,942	8,201

CRAWFORD COUNTY	1965	1980	2000	2020
Irrigation	30	200	300	500
Livestock	867	1,053	1,649	2,504
Rural Domestic	950	115	124	124
Municipal	3,359	4,019	4,720	7,152
Industrial	437	4,571	6,531	12,432





NOTE:
MUNICIPAL EXCLUDES INDUSTRIAL.
INDUSTRIAL INCLUDES MINING, MANUFACTURING, AND UTILITIES.

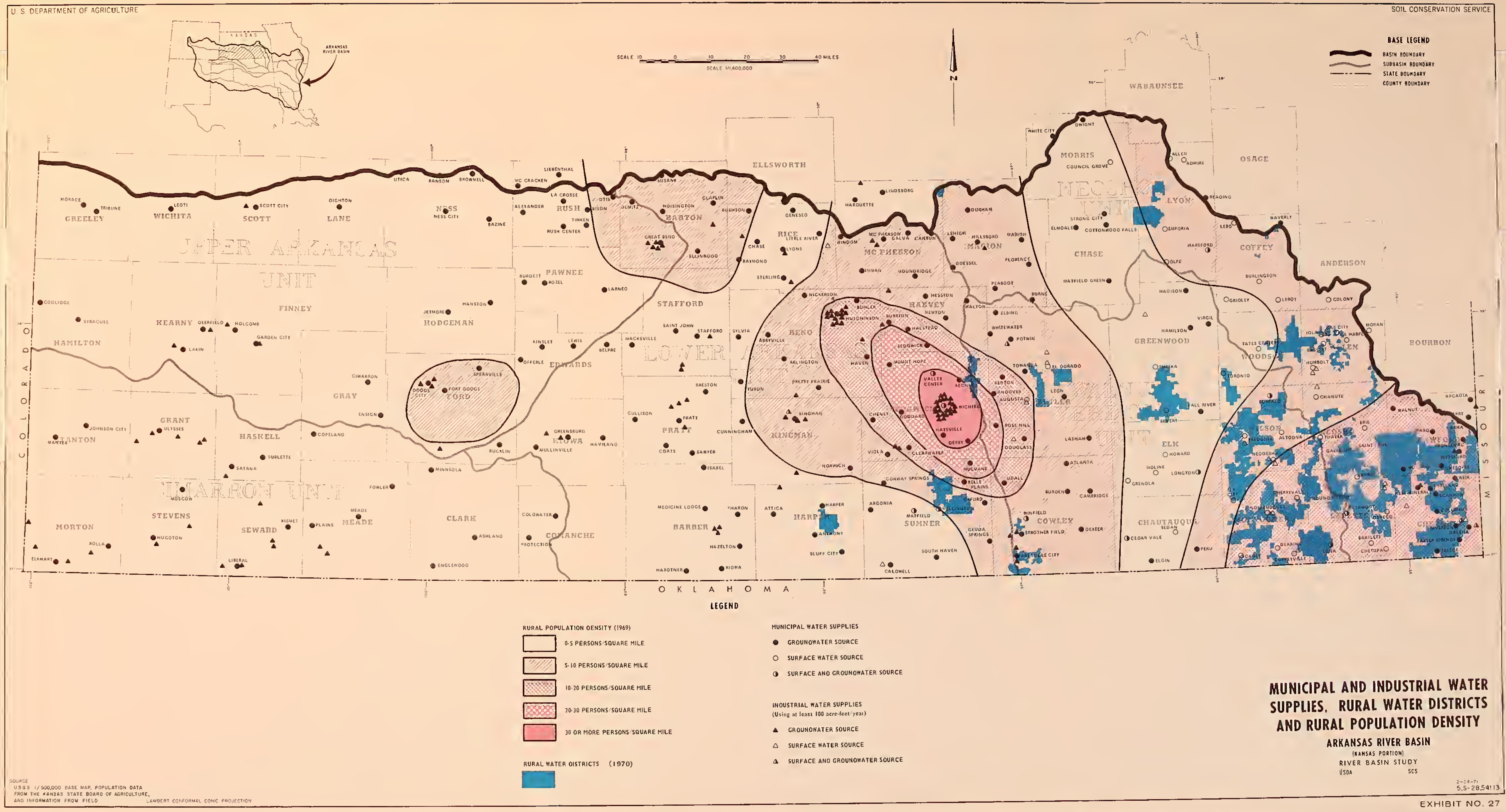
WOODSON COUNTY	1965	1980	2000	2020
Irrigation	200	1,000	1,500	2,800
Livestock	625	1,390	3,093	4,696
Rural Domestic	183	108	143	130
Municipal	193	473	639	1,009
Industrial	96	227	378	764

NEOSHO COUNTY	1965	1980	2000	2020
Irrigation	320	1,900	2,500	4,700
Livestock	898	1,199	1,928	2,927
Rural Domestic	388	121	128	122
Municipal	2,047	2,100	2,719	4,020
Industrial	1,453	3,196	5,103	10,438

CHEROKEE COUNTY	1965	1980	2000	2020
Irrigation	50	500	800	1,000
Livestock	603	792	1,480	2,248
Rural Domestic	538	113	127	135
Municipal	1,644	2,151	2,565	3,826
Industrial	171,529	4,096	8,067	15,147

LABETTE COUNTY	1965	1980	2000	2020
Irrigation	70	700	1,300	3,000
Livestock	1,165	1,680	3,067	4,656
Rural Domestic	512	164	181	170
Municipal	2,189	2,999	3,870	5,540
Industrial	2,436	6,636	13,984	30,953

USDA-SCS-LINCOLN, NEBR. 1972


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ARKANSAS RIVER BASIN
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0 10 20 30 40 MILES
BASE LEGEND
BASIN BOUNDARY
SUBBASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
UPPER ARKANSAS UNIT
LOWER ARKANSAS UNIT
CIMARRON UNIT
NEOSHO UNIT
COLORADO
OKLAHOMA
MISSOURI
LEGEND
RURAL POPULATION DENSITY (1969)
0-5 PERSONS/SQUARE MILE
5-10 PERSONS/SQUARE MILE
10-20 PERSONS/SQUARE MILE
20-30 PERSONS/SQUARE MILE
30 OR MORE PERSONS/SQUARE MILE
RURAL WATER DISTRICTS (1970)
MUNICIPAL WATER SUPPLIES
GROUNDWATER SOURCE
SURFACE WATER SOURCE
SURFACE AND GROUNDWATER SOURCE
INDUSTRIAL WATER SUPPLIES
(Using at least 100 acre-feet/year)
GROUNDWATER SOURCE
SURFACE WATER SOURCE
SURFACE AND GROUNDWATER SOURCE
MUNICIPAL AND INDUSTRIAL WATER SUPPLIES, RURAL WATER DISTRICTS AND RURAL POPULATION DENSITY
ARKANSAS RIVER BASIN
(KANSAS PORTION)
RIVER BASIN STUDY
USDA SCS
SOURCE
USGS 1/500,000 BASE MAP, POPULATION DATA
FROM THE KANSAS STATE BOARD OF AGRICULTURE,
AND INFORMATION FROM FIELD
LAMBERT CONFORMAL CONIC PROJECTION
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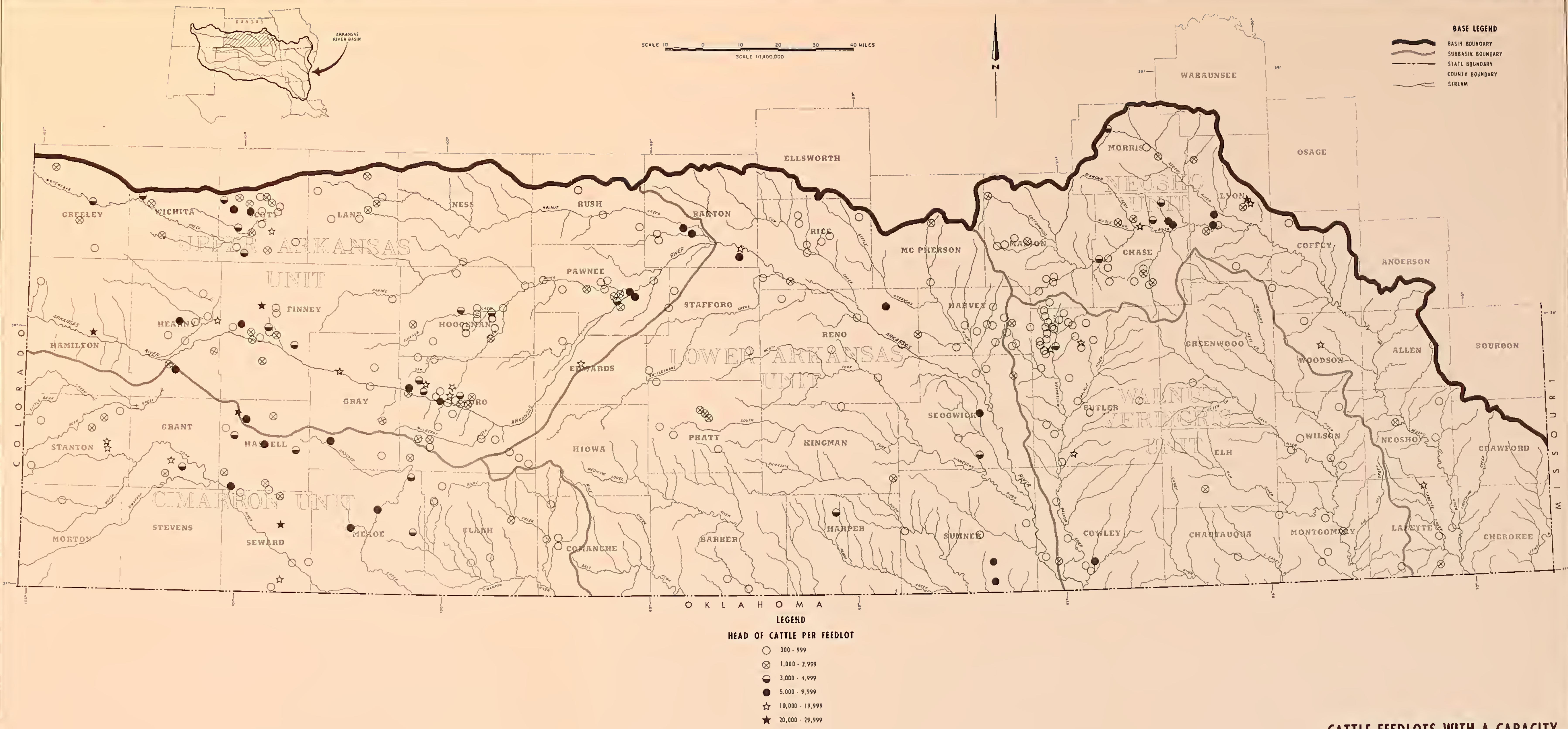
EXHIBIT NO. 27

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



CATTLE FEEDLOTS WITH A CAPACITY OF 300 HEAD OR MORE-1970

ARKANSAS RIVER BASIN

(KANSAS PORTION)

RIVER BASIN STUDY

USDA SCS

SOURCE.
USGS 1/500,000 BASE MAP, KANSAS STATE BOARD OF HEALTH, AND INFORMATION FROM FIELD.

LAMBERT CONFORMAL CONIC PROJECTION

2-18-71
5,S-28,5419

EXHIBIT NO. 28

Exhibit No. 29

RECREATION SUPPLY AND DEMAND BY COUNTIES

UPPER ARKANSAS UNIT

SCOTT COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	115 1/	26	75	151	241
Fishing	115	89	173	276	407
Swimming	8	4	11	23	37
Camping	15	2	8	18	28
Picnicking	55	4	8	14	22

LANE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	21 1/	13	37	67	94
Fishing	21	47	85	123	158
Swimming	3	2	6	10	14
Camping	0	1	4	8	11
Picnicking	26	2	4	6	8

WICHITA COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	13	38	77	122
Fishing	0	45	88	142	206
Swimming	4	2	6	12	19
Camping	5	1	4	9	14
Picnicking	5	2	4	7	11

NESS COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	25	66	119	165
Fishing	0	86	154	219	278
Swimming	4	4	10	18	25
Camping	0	2	7	14	19
Picnicking	2	3	7	11	15

GREELEY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	9	27	56	88
Fishing	0	33	63	104	149
Swimming	2	2	4	9	13
Camping	0	1	3	7	10
Picnicking	6	1	3	5	8

RUSH COUNTY

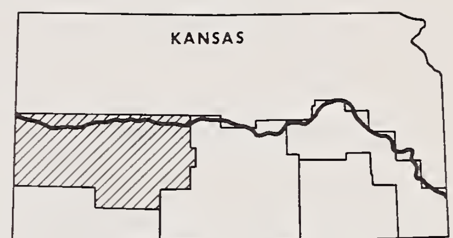
	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	26	71	128	176
Fishing	0	92	165	234	297
Swimming	5	4	11	20	27
Camping	11	2	8	15	21
Picnicking	16	4	8	12	16

HAMILTON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	94 1/	14	42	86	136
Fishing	94	50	96	157	230
Swimming	11	2	6	13	21
Camping	1	1	5	10	16
Picnicking	11	2	4	8	12

PAWNEE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	50 1/	46	125	224	309
Fishing	50	161	289	410	522
Swimming	20	7	19	34	47
Camping	0	3	14	26	36
Picnicking	94	7	13	21	28



BOATING AND FISHING IN ACRES OF WATER AREA
SWIMMING IN 1000'S OF SQUARE FEET OF WATER AREA
CAMPING AND PICNICKING IN ACRES OF LAND AREA

1/ FOR FISHING ONLY
2/ PRIVATE

KEARNY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	3000	14	42	86	136
Fishing	3000	47	85	123	158
Swimming	11	2	6	13	21
Camping	50	1	5	10	16
Picnicking	34	2	4	8	12

EDWARDS COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	22	59	107	148
Fishing	10	80	138	196	249
Swimming	0	4	9	16	23
Camping	0	2	7	12	17
Picnicking	8	3	6	10	13

FINNEY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	374 1/	83	244	498	786
Fishing	374	289	567	912	1328
Swimming	7	14	38	76	120
Camping	0	6	27	58	93
Picnicking	97	12	26	47	71

HODGEMAN COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	87 1/	13	37	67	94
Fishing	87	47	85	123	157
Swimming	4	2	6	10	14
Camping	0	1	4	8	11
Picnicking	3	2	4	6	8

GRAY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	21	59	123	196
Fishing	6 2/	72	138	226	331
Swimming	4	3	9	19	30
Camping	6	2	7	14	23
Picnicking	25	3	6	12	18

FORD COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	112 1/	101	296	605	954
Fishing	112	352	688	1108	1611
Swimming	43	17	46	93	146
Camping	236	7	33	70	112
Picnicking	9	14	32	57	86

Exhibit No. 29

RECREATION SUPPLY AND DEMAND BY COUNTIES

CIMARRON UNIT

GRANT COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	26	75	157	247
Fishing	44	91	140	287	417
Swimming	6	4	11	24	38
Camping	3	2	8	18	29
Picnicking	22	4	8	15	21

HASKELL COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	16	46	96	153
Fishing	0	56	107	176	259
Swimming	17	27	7	15	23
Camping	4	1	5	11	18
Picnicking	9	2	5	9	14

STANTON COUNTY

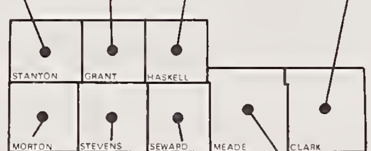
	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	10	31	62	96
Fishing	0	36	71	115	163
Swimming	0	2	5	10	15
Camping	1	1	3	7	11
Picnicking	4	1	3	6	9

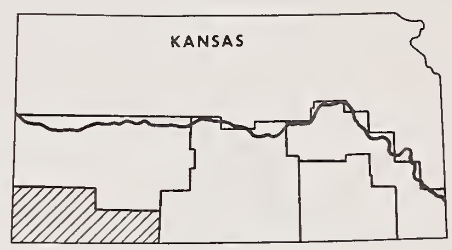
CLARK COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	427[1]	15	42	75	105
Fishing	427	53	96	135	144
Swimming	35	3	6	12	16
Camping	8	1	5	9	12
Picnicking	34	2	4	7	10

BOATING AND FISHING IN ACRES OF WATER AREA
SWIMMING IN 1000'S OF SQUARE FEET OF WATER AREA
CAMPING AND PICNICKING IN ACRES OF LAND AREA

1/ 337 ACRES FOR FISHING ONLY
2/ 100 ACRES FOR FISHING ONLY





MORTON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	17	51	105	165
Fishing	27	61	118	192	278
Swimming	6	3	8	16	25
Camping	0	1	6	12	19
Picnicking	20	2	6	10	15

MEADE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	120[2]	25	74	149	238
Fishing	125	88	171	272	403
Swimming	24	4	11	23	36
Camping	30	2	8	17	11
Picnicking	57	4	8	14	22

STEVENS COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	21	62	126	199
Fishing	17	73	143	230	336
Swimming	15	4	9	19	30
Camping	1	1	7	15	23
Picnicking	5	3	7	12	18

SEWARD COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	74	205	444	701
Fishing	95	258	476	813	1184
Swimming	3	12	32	68	107
Camping	0	5	23	51	83
Picnicking	8	10	22	42	63

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Exhibit No. 29

RECREATION SUPPLY AND DEMAND BY COUNTIES

LOWER ARKANSAS UNIT

RICE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	25[2]	47	42	34	26
Fishing	159[2]	206	366	514	647
Swimming	37	10	24	43	59
Camping	27	4	17	23	45
Picnicking	138	8	17	26	35

RENO COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	4,747	277	747	1,402	1,987
Fishing	4,989	968	1,735	2,568	3,355
Swimming	56	46	115	215	304
Camping	188	19	83	163	234
Picnicking	946	39	81	132	179

BARTON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	36[2]	147	434	885	1,396
Fishing	12,290[5]	514	1,008	1,622	2,358
Swimming	43	25	67	136	214
Camping	0	10	48	103	165
Picnicking	50	21	47	84	126

McPHERSON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	207	110	294	529	950
Fishing	207[2]	383	683	937	1,246
Swimming	16	18	45	81	113
Camping	68	8	33	41	87
Picnicking	175	15	32	50	67

STAFFORD COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	80[2]	30	58	147	202
Fishing	6,363[6]	106	190	268	340
Swimming	72	5	13	22	31
Camping	65	2	9	17	24
Picnicking	57	4	11	14	18

HARVEY COUNTY

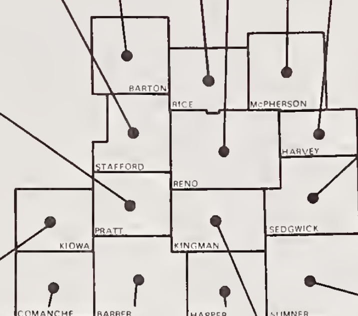
	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	110[2]	117	333	705	1,113
Fishing	235[4]	410	774	1,292	1,879
Swimming	555	20	51	108	170
Camping	12	8	37	82	131
Picnicking	112	16	36	67	101

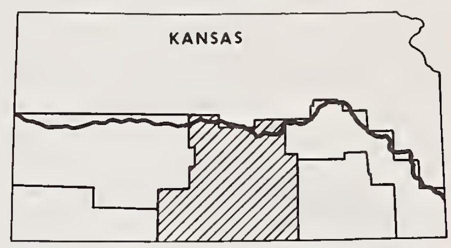
PRATT COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	90	54	146	262	360
Fishing	156	156	339	479	609
Swimming	28	9	22	40	55
Camping	127	4	16	30	43
Picnicking	144	8	16	25	33

SEDGWICK COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	308	1,980	4,542	9,500	15,200
Fishing	1,644	4,297	7,120	11,780	17,360
Swimming	660	344	775	1,617	2,583
Camping	75	123	300	613	1,072
Picnicking	548	286	541	988	1,514





BOATING AND FISHING IN ACRES OF WATER AREA
SWIMMING IN 1000'S OF SQUARE FEET OF WATER AREA
CAMPING AND PICNICKING IN ACRES OF LAND AREA

1/ FOR FISHING ONLY
2/ PRIVATE
3/ 185 ACRES FOR FISHING ONLY
4/ 87 ACRES PRIVATE
5/ WATERFOWL REFUGE - NOT ALL FISHABLE
6/ WILDLIFE REFUGE - MOSTLY NOT FISHABLE
7/ 100 ACRES PRIVATE

KIOWA COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	21	57	105	148
Fishing	48	72	132	192	249
Swimming	10	3	9	16	23
Camping	5	1	6	12	17
Picnicking	19	3	6	10	11

SUMNER COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	390	109	294	529	732
Fishing	490[7]	380	683	970	1,237
Swimming	31	18	45	81	112
Camping	66	8	33	62	87
Picnicking	335	15	32	50	66

COMANCHE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	14	38	69	96
Fishing	22[2]	48	88	127	163
Swimming	9	2	6	11	15
Camping	10	1	4	8	11
Picnicking	9	2	4	6	9

KINGMAN COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	224[3]	43	115	205	281
Fishing	272	150	267	376	475
Swimming	15	7	18	31	43
Camping	3	3	13	24	33
Picnicking	42	6	12	19	254

BARBER COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	51[1]	36	98	176	244
Fishing	138[4]	127	228	322	412
Swimming	17	6	15	27	37
Camping	2	3	11	20	29
Picnicking	22	5	11	17	22

HARPER COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	160	39	106	188	258
Fishing	170	138	245	345	436
Swimming	14	7	16	29	40
Camping	1	3	12	22	30
Picnicking	12	6	11	18	23

Exhibit No. 29

RECREATION SUPPLY AND DEMAND BY COUNTIES

NEOSHO UNIT

MORRIS COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	3294	32	85	153	210
Fishing	3294	111	198	280	355
Swimming	5	5	13	23	32
Camping	37	2	9	18	25
Picnicking	61	4	9	14	19

LYON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	535	129	381	779	1226
Fishing	540	459	884	1426	2071
Swimming	11	22	59	119	187
Camping	0	9	42	91	145
Picnicking	105	18	41	73	111

CHASE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	0	16	44	80	111
Fishing	118	56	102	146	187
Swimming	18	3	7	12	17
Camping	22	1	5	9	13
Picnicking	31	2	5	8	10

COFFEY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	7860	34	71	163	224
Fishing	7935	115	212	299	379
Swimming	282	6	14	25	34
Camping	29	2	10	19	26
Picnicking	48	5	10	15	20

MARION COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	6313	66	177	314	429
Fishing	6314	231	410	575	724
Swimming	22	11	27	48	66
Camping	10	5	19	36	51
Picnicking	182	9	19	29	39

ALLEN COUNTY

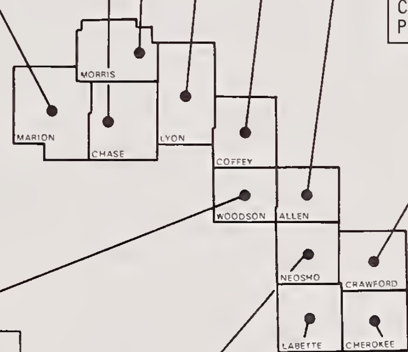
	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	15	73	196	347	474
Fishing	78[1]	236	454	669	800
Swimming	28	12	30	53	72
Camping	16	5	22	40	56
Picnicking	44	10	21	33	43

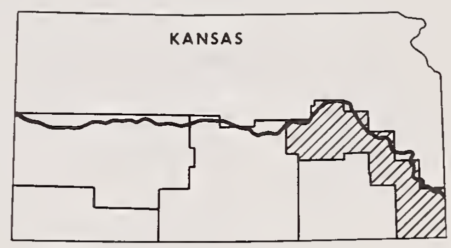
CRAWFORD COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	260	162	432	764	1039
Fishing	314	567	1002	1399	1754
Swimming	51	27	66	117	159
Camping	14	11	48	89	122
Picnicking	87	23	47	72	94

BOATING AND FISHING IN ACRES OF WATER AREA
SWIMMING IN 1000'S OF SQUARE FEET OF WATER AREA
CAMPING AND PICNICKING IN ACRES OF LAND AREA

1/ 64 ACRES PRIVATE





WOODSON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	3769	29	62	111	153
Fishing	3773	79	143	203	259
Swimming	45	38	9	17	23
Camping	182	2	7	13	18
Picnicking	148	3	7	10	14

NEOSHO COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	1108	84	223	396	539
Fishing	2816	292	518	725	911
Swimming	40	14	43	61	82
Camping	24	6	25	46	64
Picnicking	88	12	24	37	49

CHEROKEE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	394	98	260	460	627
Fishing	550	341	603	843	1059
Swimming	24	16	40	71	96
Camping	73	7	29	54	74
Picnicking	76	14	28	44	57

LABETTE COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	214	119	315	559	761
Fishing	369	414	732	1024	1285
Swimming	49	20	49	86	116
Camping	39	8	35	65	89
Picnicking	92	17	34	53	69

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USDA-SCS-LINCOLN NEBR. 19

Exhibit No. 29

RECREATION SUPPLY AND DEMAND BY COUNTIES

WALNUT VERDIGRIS UNIT

GREENWOOD COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	3626	44	119	211	289
Fishing	4094	155	275	387	489
Swimming	223	7	18	32	44
Camping	882	3	13	25	34
Picnicking	580	6	13	19	26

ELK COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	135	21	55	98	136
Fishing	135	70	123	180	230
Swimming	6	3	8	15	21
Camping	0	1	6	11	16
Picnicking	23	3	6	9	12

BUTLER COUNTY

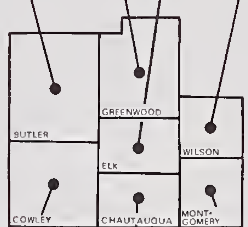
	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	1882	172	506	1034	1624
Fishing	1912	600	1176	1894	2751
Swimming	43	29	78	158	249
Camping	31	12	56	120	192
Picnicking	54	24	55	99	147

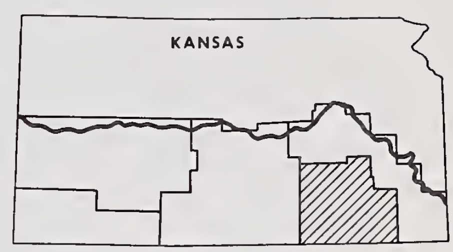
WILSON COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	119 2/	59	159	283	386
Fishing	170	208	369	518	652
Swimming	81	10	24	43	59
Camping	17	4	18	33	45
Picnicking	87	8	17	27	35

BOATING AND FISHING IN ACRES OF WATER AREA
SWIMMING IN 1000'S OF SQUARE FEET OF WATER AREA
CAMPING AND PICNICKING IN ACRES OF LAND AREA

1/ 472 ACRES PRIVATE
2/ FOR FISHING ONLY





COWLEY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	1135	163	439	785	1078
Fishing	1223	571	1015	1438	1488
Swimming	20	27	67	120	165
Camping	80	11	48	91	127
Picnicking	134	23	47	74	99

MONTGOMERY COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	3655	195	519	920	1254
Fishing	3740	682	1206	1687	2115
Swimming	69	32	80	141	401
Camping	18	14	57	107	148
Picnicking	165	28	56	87	114

CHAUTAUQUA COUNTY

	PRESENT SUPPLY	DEMAND 1965	1980	2000	2020
Boating	527 1/	25	66	119	165
Fishing	705	86	154	219	278
Swimming	26	4	10	18	25
Camping	19	2	7	14	19
Picnicking	31	3	7	11	15

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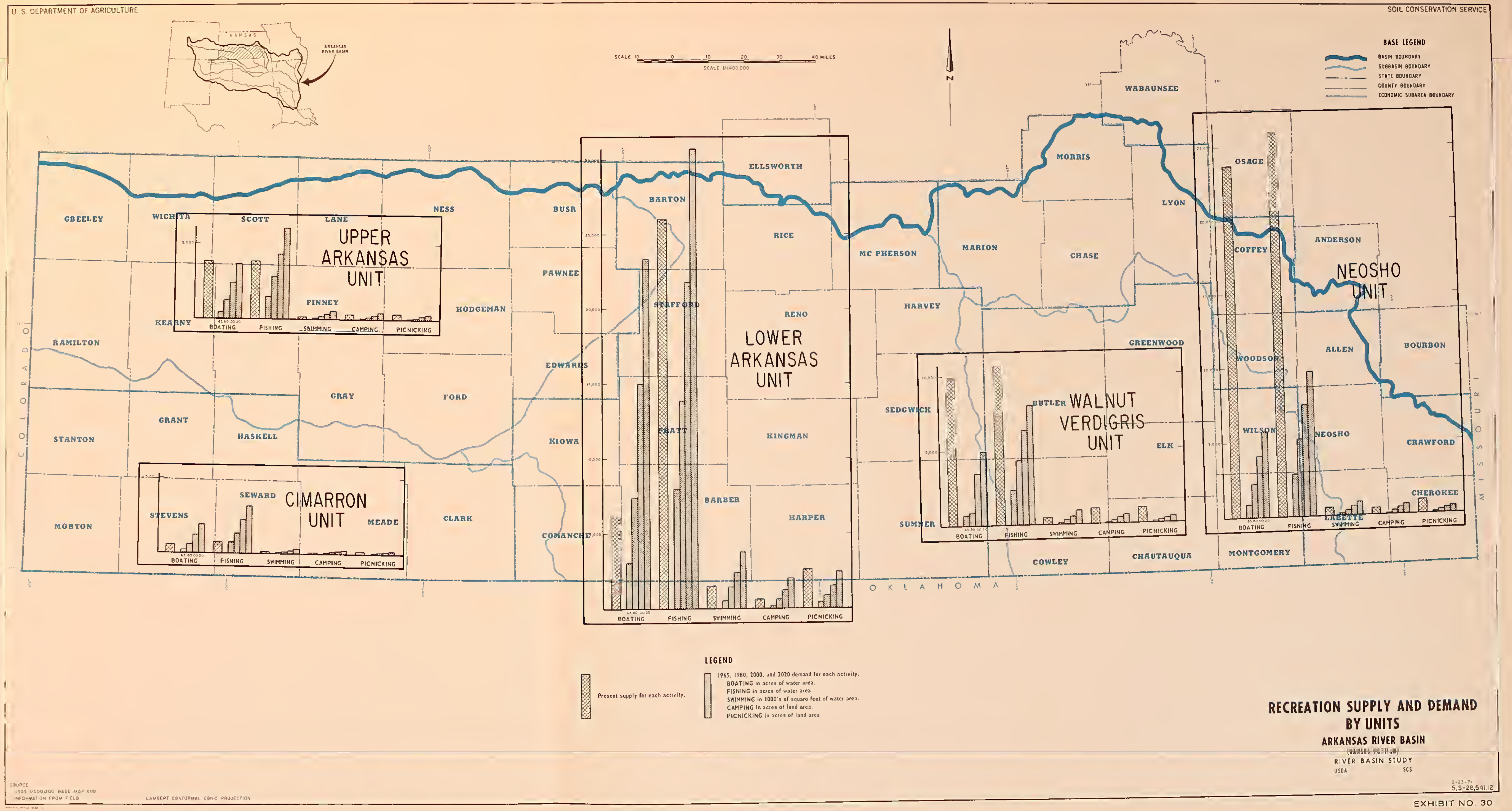


EXHIBIT NO. 30

Arkansas River Basin-Kansas

Exhibit 31 - 1965 and Projected Water Withdrawal Demands and Net Streamflow Requirements

	1965 (Acre Feet per Year)			1980 (Acre Feet per Year)			2000 (Acre Feet per Year)			2020 (Acre Feet per Year)		
	Withdrawal		Return Flow	Withdrawal		Return Flow	Withdrawal		Return Flow	Withdrawal		Return Flow
	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
Upper Arkansas Unit												
Municipal	0	13,100	6,600	0	17,000	8,500	0	22,100	11,000	0	33,700	16,800
Industrial	700	21,000	2,800	800	8,400	5,300	1,300	13,700	8,800	2,600	27,300	16,300
Rural Domestic & Livestock	1,200	12,800	0	1,600	17,500	0	2,800	27,300	0	4,200	38,800	0
Irrigation	111,400	796,700	27,800	138,700	2,155,200	34,700	164,200	3,464,900	41,000	184,400	4,035,900	46,100
Pollution Abatement	57,500 1/	0	0	81,500	0	0	111,000	0	0	173,000	0	0
Unit Total	170,800	843,600	37,200	222,600	2,198,100	48,500	279,300	3,528,000	60,800	364,200	4,135,700	79,200
	Net streamflow demand = 133,600 2/			Net streamflow demand = 174,100			Net streamflow demand = 218,500			Net streamflow demand = 285,000		
Cimarron Unit												
Municipal	0	7,200	3,600	0	10,300	5,200	0	13,500	6,700	0	20,100	10,100
Industrial	0	32,900	23,800	400	10,900	8,100	1,000	22,800	16,800	2,000	46,600	33,700
Rural Domestic & Livestock	700	4,800	0	900	7,100	0	1,300	10,300	0	1,900	13,900	0
Irrigation	0	794,900	0	0	1,760,600	0	0	2,537,100	0	0	2,998,600	0
Pollution Abatement	114,900	0	0	48,400	0	0	68,900	0	0	111,800	0	0
Unit Total	115,600	839,800	27,400	49,700	1,788,900	13,300	71,200	2,583,700	23,500	115,700	3,079,200	43,800
	Net streamflow demand = 88,200			Net streamflow demand = 36,400			Net streamflow demand = 47,700			Net streamflow demand = 71,900		
Lower Arkansas Unit												
Municipal	13,200	45,200	32,100	27,300	77,700	57,700	34,000	95,800	71,400	48,900	138,000	102,800
Industrial	10,100	55,200	38,100	30,500	70,100	68,500	57,900	142,200	133,000	113,900	288,000	258,500
Rural Domestic & Livestock	4,300	20,800	0	5,000	17,700	0	7,300	26,800	0	11,000	38,600	0
Irrigation	11,500	73,000	10,200	38,100	436,300	53,200	115,900	1,493,500	178,300	193,100	2,252,200	273,500
Pollution Abatement	380,500	0	0	627,500	0	0	929,100	0	0	1,530,300	0	0
Unit Total	419,600	194,200	80,400	728,400	601,800	179,400	1,144,200	1,758,300	382,700	1,897,200	2,716,800	634,800
	Net streamflow demand = 339,200			Net streamflow demand = 549,000			Net streamflow demand = 761,500			Net streamflow demand = 1,262,400		

EXHIBIT NO. 31

USDA-SCS-LINCOLN, NEBR. 1972

Arkansas River Basin-Kansas

Exhibit 31 - 1965 and Projected Water Withdrawal Demands and Net Streamflow Requirements

	1965 (Acre Feet per Year)			1980 (Acre Feet per Year)			2000 (Acre Feet per Year)			2020 (Acre Feet per Year)		
	Withdrawal		Return Flow	Withdrawal		Return Flow	Withdrawal		Return Flow	Withdrawal		Return Flow
	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
Walnut-Verdigris Unit												
Municipal	8,200	4,900	8,200	12,900	5,000	11,300	14,600	5,700	12,800	21,100	8,300	18,500
Industrial	55,400	4,700	16,400	20,700	9,000	21,700	43,900	15,700	35,400	74,500	29,300	66,700
Rural Domestic & Livestock	7,000	4,900	0	11,400	4,100	0	18,300	5,700	0	27,600	7,900	0
Irrigation	3,800	800	1,100	29,800	6,500	9,100	61,100	16,500	19,400	112,300	31,600	36,000
Pollution Abatement	128,900	0	0	145,600	0	0	190,000	0	0	313,900	0	0
Unit Total	203,300	15,300	25,700	220,400	24,600	42,100	327,900	43,600	67,600	549,400	77,100	121,200
	Net streamflow demand = 177,600			Net streamflow demand = 178,300			Net streamflow demand = 260,300			Net streamflow demand = 428,200		
Neosho Unit												
Municipal	8,700	6,200	9,700	11,600	8,200	12,900	14,100	9,600	15,400	20,600	14,400	22,800
Industrial	177,800	2,300	9,300	29,200	8,400	21,400	70,000	12,600	50,000	96,200	23,500	70,500
Rural Domestic & Livestock	8,300	7,700	0	13,100	7,300	0	22,900	11,100	0	34,600	16,000	0
Irrigation	2,200	100	600	19,400	1,100	5,100	43,700	4,200	12,000	90,500	9,400	25,000
Pollution Abatement	103,600	0	0	168,000	0	0	249,900	0	0	437,500	0	0
Unit Total	300,600	16,300	19,600	241,300	25,000	39,400	400,600	37,500	77,400	679,400	63,300	118,300
	Net streamflow demand = 281,000			Net streamflow demand = 201,900			Net streamflow demand = 323,200			Net streamflow demand = 561,100		
Arkansas River Basin												
Municipal	30,100	76,600	60,200	51,800	118,200	95,600	62,700	146,700	117,300	90,600	214,500	171,000
Industrial	244,000	116,100	90,400	81,600	106,800	125,000	174,100	207,000	244,000	289,200	414,700	445,700
Rural Domestic & Livestock	21,500	51,000	0	32,000	53,700	0	52,600	81,200	0	79,300	115,200	0
Irrigation	128,900	1,665,500	39,700	226,000	4,359,700	102,100	384,900	7,516,200	250,700	580,300	9,327,700	380,600
Pollution Abatement	785,400	0	0	1,071,000	0	0	1,548,900	0	0	2,566,500	0	0
Basin Total	1,209,900	1,909,200	190,300	1,462,400	4,638,400	322,700	2,223,200	7,951,100	612,000	3,605,900	10,072,100	997,300
	Net streamflow demand = 1,019,600			Net streamflow demand = 1,139,700			Net streamflow demand = 1,611,200			Net streamflow demand = 2,608,600		

1/ The Pollution Abatement demand is an instream demand. It is not actually a withdrawal but a streamflow requirement.
2/ The Net Streamflow demand is the surface withdrawal minus the total return flow.

EXHIBIT NO. 31 (CONT.)

Arkansas River Basin-Kansas

Exhibit 32 - Waste Loads Produced
(Tons Per Day)

	1965	1980	2000	2020
Upper Arkansas Unit				
Organic (BOD)				
Livestock	363.5	601.6	1051.4	1596.4
Municipal	5.6	7.4	10.3	15.7
Industrial	2.2	2.6	3.6	5.6
Inorganic (TDS)				
Cropland	13.3	44.4	65.2	81.5
Municipal	7.2	8.9	11.3	17.2
Industrial	29.3	42.3	32.1	45.7
Cimarron Unit				
Organic (BOD)				
Livestock	134.8	207.1	358.0	543.6
Municipal	3.1	3.8	5.5	8.2
Industrial	0.6	1.0	1.9	4.0
Inorganic (TDS)				
Cropland	6.3	20.9	30.9	39.9
Municipal	4.0	4.6	6.0	9.0
Industrial	56.2	90.1	68.6	95.0
Lower Arkansas Unit				
Organic (BOD)				
Livestock	562.3	772.1	1232.4	1871.1
Municipal	41.5	65.4	89.6	129.2
Industrial	20.1	28.6	50.4	90.5
Inorganic (TDS)				
Cropland	19.5	56.3	83.3	109.4
Municipal	53.0	79.3	98.3	141.4
Industrial	288.6	440.8	372.1	392.9
Walnut-Verdigris Unit				
Organic (BOD)				
Livestock	329.6	561.5	898.9	1364.8
Municipal	9.7	14.9	18.7	26.9
Industrial	8.7	10.5	12.4	21.6
Inorganic (TDS)				
Cropland	5.8	18.5	24.2	29.8
Municipal	12.4	18.1	20.5	29.5
Industrial	74.2	115.0	90.0	126.8

Exhibit 32 - Waste Loads Produced
(Tons Per Day)

	1965	1980	2000	2020
Neosho Unit				
Organic (BOD)				
Livestock	452.3	751.8	1296.3	1968.3
Municipal	11.4	18.4	24.5	36.2
Industrial	8.0	10.0	13.9	24.1
Inorganic (TDS)				
Cropland	11.6	40.3	50.5	61.7
Municipal	14.6	22.4	26.8	39.7
Industrial	56.0	79.7	68.2	99.7

Arkansas River Basin-Kansas
Exhibit 33 - Phreatophyte Acreage
between Colorado-Kansas Stateline and Great Bend, Kansas
1967

Plant Species	Vegetative Cover			
	Type I 1/	Type II 2/	Type III 3/	Total
	acres	acres	acres	acres
Mixed stands of:				
Salt Cedar (Tamarisk ramosissimi) : Cottonwood (Populus sargentii) : Willow (Salix interior)	4,199	8,204	10,439	22,842

1/ Type I included stands of salt cedar with not more than 10 percent (estimated) willow, cottonwood, or both

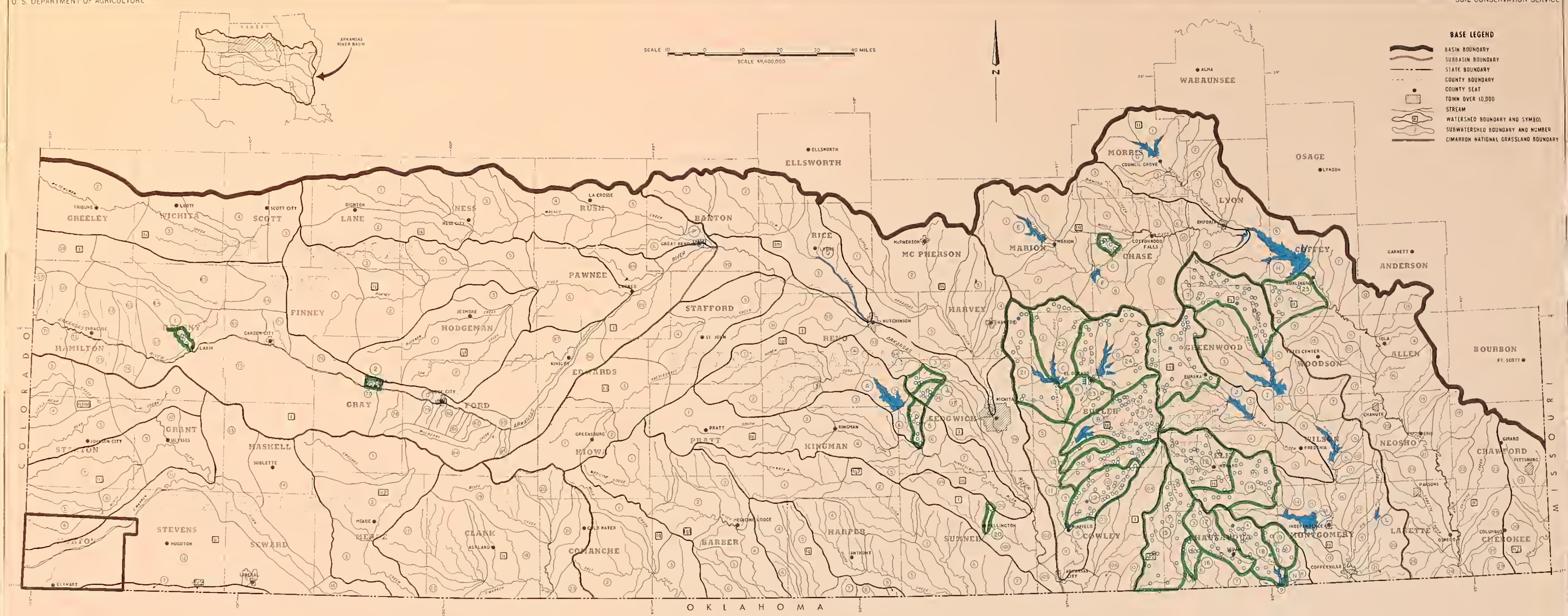
2/ Type II included mixed stands of two or all three species, but always included salt cedar

3/ Type III included stands of cottonwood, willow, or both, or other tree species, but with less than 10 percent salt cedar

Source: Division of Biological Science,
Fort Hays, Kansas State College

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



LEGEND

- SINGLE PURPOSE FLOODWATER RETARDING STRUCTURE
- MULTIPLE PURPOSE STRUCTURE
- PL-566 WATERSHED BOUNDARY
- LOCAL PROTECTION WORK
- CHANNEL MODIFICATION
- RESERVOIR

PL-566 WATERSHED PROJECTS

1. Lakin (C)
2. Cimarron (C)
3. Mount Hope (A)
4. Andale (U)
5. Spring Creek (C)
6. Silver Creek (C)
7. Upper Verdigris (U)
8. Fall River (C)
9. Little Walnut Hickory (C)
10. Muddy Creek (C)
11. Rock Creek (U)
12. Timber Creek (U)
13. Upper Elk River (U)
14. Lower Elk River (U)
15. Big Caney (U)
16. Grant Shanghai (U)
17. Middle Caney (C)
18. Twin Caney (C)
19. Bee Creek (C)
20. Hargis Creek (C)
21. West Sector Whitewater River (A)
22. East Sector Whitewater River (A)
23. South Sector Upper Walnut River (A)
24. North Sector Upper Walnut River (A)
25. Big Creek (A)

(C) - Completed (U) - Under Construction (A) - Authorized Project status as of 12-31-74

BUREAU OF RECLAMATION PROJECT

- (A) Cheney Reservoir (C)

CORPS OF ENGINEERS PROJECTS

- (B) Douglas Reservoir (A)
- (C) Towanda Reservoir (A)
- (D) Eldorado Reservoir (A)
- (E) Marion Reservoir (C)
- (F) Cedar Point Reservoir (A)
- (G) Council Grove Reservoir (C)
- (H) John Redmond Reservoir (C)
- (I) Toronto Reservoir (C)

CORPS OF ENGINEERS PROJECTS

- (J) Fall River Reservoir (C)
- (K) Neodesha Reservoir (A)
- (L) Big Hill Reservoir (A)
- (M) Elk City Reservoir (C)
- (N) Copan Reservoir (A)
- (O) Dodge City Local Protection Works (U)
- (P) Great Bend Local Protection Works (A)
- (Q) Cow Creek Channel Improvement (A)
- (R) Eldorado Local Protection Works (C)
- (S) Winfield Local Protection Works (C)

AUTHORIZED WATER RESOURCE PROJECTS

ARKANSAS RIVER BASIN

(KANSAS PORTION)

RIVER BASIN STUDY

USDA SCS

SOURCE
USGS 1/500,000 BASE MAP AND INFORMATION FROM FIELD

LAMBERT CONFORMAL CONIC PROJECTION

REV. 6-24-75
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EXHIBIT NO 34

Arkansas River Basin - Kansas

Exhibit 35 - Summary of Structure Data for Watersheds
Watershed Projects Authorized for Planning or Construction

Wshd. Iden. Code No.	Upstream Floodwater Retarding Structures							Channel Improv. Miles	Installation Costs			Av. Ann. Costs[1]
	No.	D.A. Controlled Sq.Mi.	Pool Capacity			Surface Area			Struc. $	Channel Improve. $	Total $	
			Sed. Ac.Ft.	Det. Ac.Ft.	Other Ac.Ft.	Perm. Ac.	Det. Ac.					
Upper Arkansas Unit												
1-68	4	12.2	303	2,604	--	44	308	3.4	535,500	54,900	590,400	22,300
1-77	4	5.9	189	523	--	61	124	3.0	99,800	10,500	110,300	4,300
Subtotal	8	18.1	492	3,127	--	105	432	6.4	635,300	65,400	700,700	26,600
1k-1	5	284.0	4,051	30,859	120	374[2]	2,702	--	3,009,500	--	3,009,500	161,800
1k-2	3	97.2	1,371	9,558	--	170	937	--	768,200	--	768,200	41,300
1k-3	12	177.6	2,905	23,793	--	445	2,831	--	1,943,700	--	1,943,700	104,500
1k-4	25	211.2	3,669	32,508	--	583	3,969	--	3,022,500	--	3,022,500	162,500
1k-5	8	49.0	959	7,833	--	180	1,183	--	749,600	--	749,600	40,300
Subtotal	53	819.0[3]	12,955	104,551	120	1,752	11,622	--	9,493,500	--	9,493,500	510,400
Unit Total	61	837.1	13,447	107,678	120	1,857	12,054	6.4	10,128,800	65,400	10,194,200	537,000
Lower Arkansas Unit												
1-95	4	14.4	352	3,291	--	65	656	6.5	529,200	266,400	795,600	39,100
1-96	6	12.5	304	2,198	--	93	413	2.6	306,200	42,000	348,200	13,100
1-100	1	8.0	442	2,165	358[4]	176[5]	273	--	494,800	--	494,800	28,700
Subtotal	11	34.9	1,098	7,654	358	334	1,342	9.1	1,330,200	308,400	1,638,600	80,900
1n-4	3	18.9	1,211	4,551	--	163	633	--	478,000	--	478,000	25,700
101-7	3	5.9	301	758	--	56	140	--	205,200	--	205,200	7,500
Unit Total	17	59.7	2,610	12,963	358	553	2,115	9.1	2,013,400	308,400	2,321,800	114,100

Footnotes on last page of exhibit

Exhibit 35 - Summary of Structure Data for Watersheds
Watershed Projects Authorized for Planning or Construction

Wshd. Iden. Code No.	Upstream Floodwater Retarding Structures							Channel Improv. Miles	Installation Costs			Av. Ann. Costs[1]
	No.	D.A. Controlled Sq.Mi.	Pool Capacity			Surface Area			Struc. $	Channel Improve. $	Total $	
			Sed. Ac.Ft.	Det. Ac.Ft.	Other Ac.Ft.	Perm. Ac.	Det. Ac.					
Walnut-Verdigris Unit												
1p-1	13	74.6	3,258	17,877	675	785[6]	2,933	--	2,639,400	--	2,639,400	147,400
1p-2	11	60.1	2,645	13,859	--	451[7]	2,393	--	1,815,600	--	1,815,600	93,100
1p-3	14	47.3	1,721	9,354	--	288	1,644	--	1,527,200	--	1,527,200	78,500
1p-4	16	83.5	2,907	17,367	--	488	2,801	--	2,431,300	--	2,431,300	120,200
1p-5&9	15	48.4	2,193	10,466	2,022[8]	632[9]	1,908	3.7	2,616,700	98,300	2,715,000	153,100
1p-6	40	92.4	2,650	17,099	40[10]	660	2,455	--	2,578,700	--	2,578,700	102,900
1p-7	2	29.5	1,032	5,135	--	109	674	--	340,800	--	340,800	12,300
1p-8	23	68.6	2,851	14,231	--	372	1,861	--	2,194,400	--	2,194,400	75,800
1p-10	35	100.7	5,799	19,483	18,075[11]	1,667[12]	3,552	--	5,398,800	--	5,398,800	198,900
Subtotal	169	605.1	25,056	124,871	20,812	5,452	20,221	3.7	21,452,900	98,300	21,641,200	982,200
1s-1	39	194.3	7,599	32,661	1,219[13]	1,000	3,370[14]	--	4,525,900	--	4,525,900	203,700
1s-12	27	139.6	6,917	29,442	--	724	2,921	--	3,979,100	--	3,979,100	141,300
1s-13	21	100.2	6,025	20,811	--	636	2,289	--	2,628,700	--	2,628,700	92,900
1s-14	6	21.6	606	4,497	--	117	769	4.8	749,100	99,400	848,500	42,600
Subtotal	93	455.8	21,147	87,411	1,219	2,477	9,349	4.8	11,882,800	99,400	11,982,200	480,200
1s1-1	27	150.3	4,821	40,100	5,372[15]	679	3,325[16]	--	4,156,900	--	4,156,900	175,900
1s2-1	33[17]	173.7[17]	7,628	35,506	--	871	2,799	2.7	4,459,700	28,200	4,487,900	151,200
1s2-2	7	11.7	762	2,207	--	82	335	5.7	457,600	80,200	537,800	18,800
1s2-3	15	109.3	3,377	19,705	660[18]	382	1,677[19]	--	2,165,900	--	2,165,900	97,400
1s2-4	16	83.9	2,652	15,911	9,310[20]	422	1,836[21]	26.7	2,116,600	1,299,000	3,415,600	145,700
1s2-5	7	28.8	1,070	5,628	--	194	715	9.7	604,000	175,600	779,600	31,200
Subtotal	78	407.4	15,489	78,957	9,970	1,951	7,362	44.8	9,803,800	1,583,000	11,386,800	444,300
Unit Total	367	1,618.6	66,513	331,339	37,373	10,559	40,257	53.3	47,296,400	1,780,700	49,167,000	2,082,900

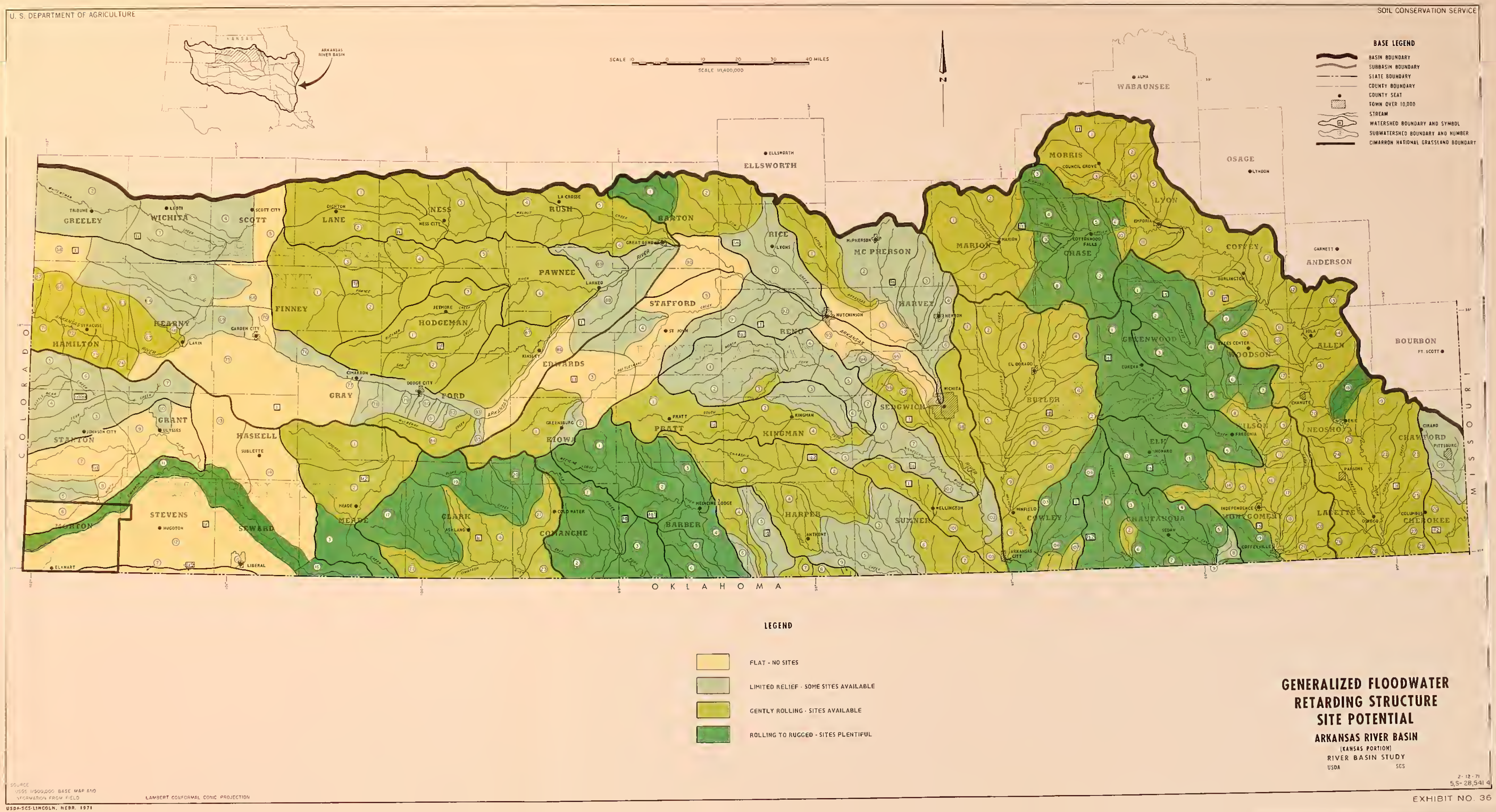
Arkansas River Basin-Kansas

Exhibit 35 - Summary of Structure Data for Watersheds

Watershed Projects Authorized for Planning or Construction

Wshd. Iden. Code No.	Upstream Floodwater Retarding Structures							Channel Improv. Miles	Installation Costs			Av. Ann. Costs 1/
	No.	D.A. Controlled Sq.Mi.	Pool Capacity			Surface Area			Struc. $	Channel Improve. $	Total $	
			Sed. Ac.Ft.	Det. Ac.Ft.	Other Ac.Ft.	Perm. Ac.	Det. Ac.					
Neosho Unit												
1t-8	9	41.5	2,194	8,038	--	340	1,315	--	1,450,700	--	1,450,700	75,400
1t1-9	6	10.2	303	2,514	--	59	217	2.0	409,600	29,500	439,100	17,600
Unit Total	15	51.7	2,497	10,552	--	399	1,532	2.0	1,860,300	29,500	1,889,800	93,000
Basin Total	460	2,567.1	85,067	462,532	37,851	13,368	55,958	70.8	61,298,900	2,184,000	63,572,900	2,827,000

1/ Year of planning
2/ Includes 90-acre recreation lake
3/ Contributing drainage area of structures
4/ Storage for recreation
5/ Includes 106 acres for recreation
6/ Includes 120 acres for recreation
7/ Includes 476 acres for recreation and water supply
8/ Includes 663 acre feet for recreation and 1,359 acre feet for municipal and industrial water supply
9/ Includes 118 acres for recreation and 154 acres for municipal and industrial
10/ Includes 40 acre feet for water supply
11/ Includes 9,037 acre feet for recreation and 9,038 acre feet for municipal water supply - city of Winfield
12/ Includes 1,120 acres for recreation
13/ Includes 1,219 acre feet for water supply
14/ Includes 114 acres for water supply
15/ Municipal water supply - city of Eureka
16/ Includes 259 acres for municipal water
17/ Includes one structure located in Oklahoma with 3.30 square miles drainage area
18/ Municipal water supply - city of Sedan
19/ Includes 69 acres for water supply
20/ Includes 9,310 acre feet for water supply
21/ Includes 561 acres for water supply


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ARKANSAS RIVER BASIN
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CIMARRON NATIONAL GRASSLAND BOUNDARY
GREELEY
WICHITA
SCOTT
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BARTON
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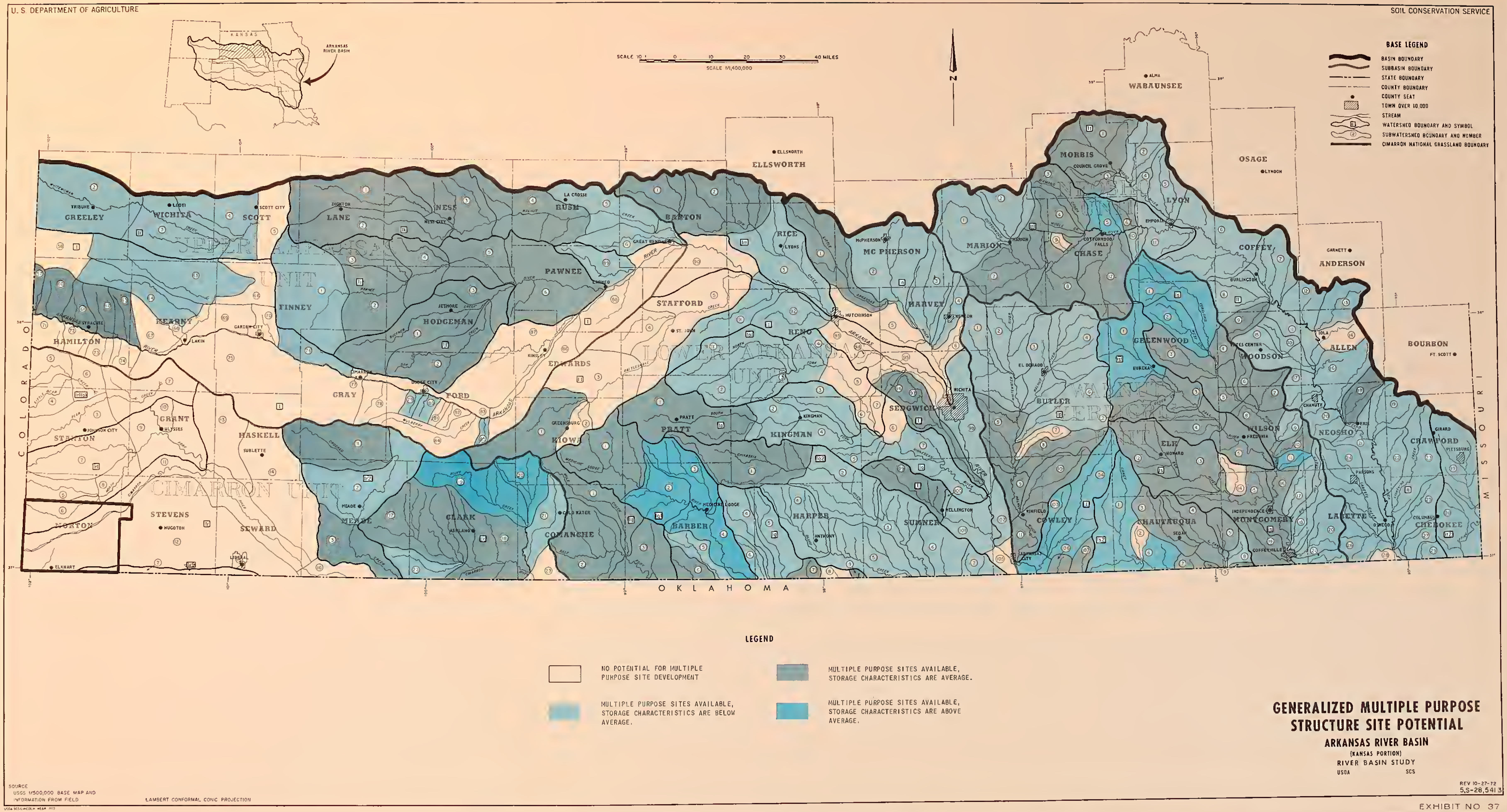
RICE
MC PHERSON
MARION
MORRIS
WABAUNSEE
OSAGE
LYON
CHASE
COFFEY
ANDERSON
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
STAFFORD
RENO
HARVEY
BUTLER
GREENWOOD
WOODSON
ALLEN
BOURBON
STANTON
GRANT
HASKELL
GRAY
FORD
EDWARDS
KIOWA
PRATT
KINGMAN
SEDGWICK
ELK
WILSON
NEOSHO
CRAWFORD
MORTON
STEVENS
SEWARD
MEADE
CLARK
COMANCHE
BARBER
HARPER
SUMNER
COWLEY
CHAUTAUQUA
MONTGOMERY
LABETTE
CHEROKEE
COLORADO
OKLAHOMA
MISSOURI
LEGEND
FLAT - NO SITES
LIMITED RELIEF - SOME SITES AVAILABLE
GENTLY ROLLING - SITES AVAILABLE
ROLLING TO RUGGED - SITES PLENTIFUL
GENERALIZED FLOODWATER RETARDING STRUCTURE SITE POTENTIAL
ARKANSAS RIVER BASIN
(KANSAS PORTION)
RIVER BASIN STUDY
USDA SCS
2-12-71
5,S-28,541 4
SOURCE
USGS 1/500,000 BASE MAP AND INFORMATION FROM FIELD
LAMBERT CONFORMAL CONIC PROJECTION
USDA-SCS-LINCOLN, NEBR. 1971
EXHIBIT NO. 36



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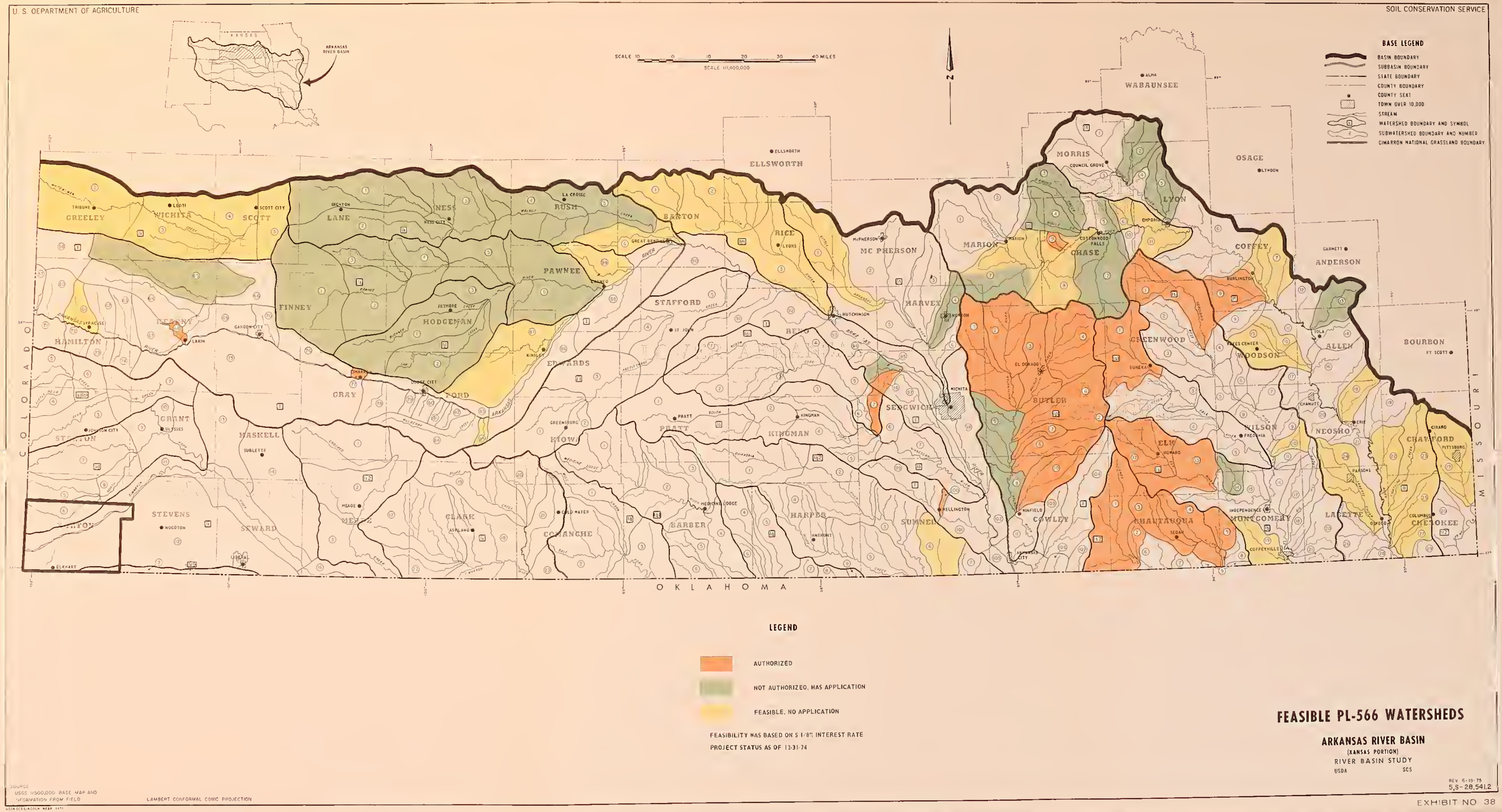


EXHIBIT NO. 38

Arkansas River Basin-Kansas
Exhibit 39 - Summary of Structure Data for a Potential System
Early Action Watershed Projects

Wshd. Iden. Code No.	Upstream Floodwater Retarding Structures							Channel Improv. Miles	Installation Costs			Av. Ann. Costs[1] $
	No.	D.A. Controlled Sq.Mi.	Pool Capacity			Surface Area			Struc. $	Channel Improve. $	Total $	
			Sed. Ac.Ft.	Det. Ac.Ft.	Other Ac.Ft.	Perm. Ac.	Det. Ac.					
Upper Arkansas Unit												
1-61	2	21.8	174	2,663	216[2]	65[3]	242	--	323,700	--	323,700	18,000
1-65	6	298.4	2,863	39,029	420[2]	524[4]	2,740	28[5]	2,033,900	721,900	2,755,800	149,600
1-85	1	9.8	350	1,578	89[2]	36[6]	195	--	179,500	--	179,500	10,000
1-87	10	234.9	6,250	32,594	513[2]	715[7]	2,790	--	2,210,000	--	2,210,000	120,800
1-89	3	35.8	1,549	4,446	214[2]	157[8]	565	12	515,800	672,200	1,188,000	65,900
Subtotal	22	600.7	11,186	80,310	1,452	1,497	6,532	40	5,262,900	1,394,100	6,657,000	364,300
1j-1	5	262.8	4,633	35,437	428[2]	635[9]	2,280	--	1,654,300	--	1,654,300	90,700
1j-2	4	123.3	1,972	12,022	260[2]	463[10]	1,420	--	1,064,300	--	1,064,300	58,400
1j-3	1	49.0	784	6,267	316[2]	183[11]	570	--	396,300	--	396,300	22,000
1j-4	2	86.9	1,978	11,670	326[2]	286[12]	900	--	701,300	--	701,300	38,700
1j-5	5	42.9	1,387	5,664	244[2]	193[13]	760	--	648,500	--	648,500	35,700
1j-6	8	101.5	2,710	13,644	199[2]	324[14]	1,715	--	1,246,400	--	1,246,400	68,100
Subtotal	25	666.4	13,464	84,704	1,773	2,084	7,645	--	5,711,100	--	5,711,100	313,600
1jl-1[62]	--	--	--	--	--	--	--	--	---	--	--	--
1jl-2	3	140.1	3,267	20,538	225[2]	413[15]	1,380	--	1,007,800	--	1,007,800	55,300
1jl-3	5	44.1	1,474	6,141	302[2]	193[16]	660	--	616,100	--	616,100	33,900
Subtotal	8	184.2	4,741	26,679	527	606	2,040	--	1,623,900	--	1,623,900	89,200
1i-2	6	394.0[17]	4,200	42,000	--	850	3,080	--	2,444,300	--	2,444,300	133,100
1i-3	2	257.0	2,492	23,845	440[2]	395[18]	2,040	--	1,204,500	--	1,204,500	66,200
1i-4	1	99.0	1,188	11,345	--	190	605	--	415,800	--	415,800	22,600
1i-5[62]	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	9	750.0	7,880	77,190	440	1,435	5,725	--	4,064,600	--	4,064,600	221,900
1k-6	9	52.9	1,639	6,767	331[2]	231[19]	952	--	821,000	--	821,000	45,300
Unit Total	73	2,254.2	38,910	275,650	4,523	5,853	22,894	40	17,483,500	1,394,100	18,877,600	1,034,300

Footnotes on last page of exhibit

Arkansas River Basin-Kansas
Exhibit 39 - Summary of Structure Data for a Potential System
Early Action Watershed Projects

Wshd. Iden. Code No.	Upstream Floodwater Retarding Structures							Channel Improv. Miles	Installation Costs			Av. Ann. Costs[1]
	No.	D.A. Controlled Sq.Mi.	Pool Capacity			Surface Area			Struc. $	Channel Improve. $	Total $	
			Sed. Ac.Ft.	Det. Ac.Ft.	Other Ac.Ft.	Perm. Ac.	Det. Ac.					
Lower Arkansas Unit												
lm-1	4	53.2	1,987	7,022	1,640[2]	628[20]	997	8	1,447,100	355,300	1,802,400	103,100[21]
lm-2	7	124.4	4,640	16,783	400[2]	637[22]	2,174	--	1,895,000	--	1,895,000	110,900[23]
lm-3	1	26.0	970	3,686	750[2]	325[24]	400	8	769,300	329,600	1,098,900	68,500[25]
Subtotal	12	203.6	7,597	27,491	2,790	1,590	3,571	16	4,111,400	684,900	4,796,300	282,500
ln-1	16	140.2	6,728	23,360	475[2]	806[26]	2,952	--	3,445,200	--	3,445,200	194,100[27]
lq2-6	4	52 .6	2,936	11,545	800[2]	519[28]	1,536	--	1,629,600	--	1,629,600	96,900[29]
Unit Total	32	396.4	17,261	62,396	4,065	2,915	8,059	16	9,186,200	684,900	9,871,100	573,500
Walnut-Verdigris Unit												
ls-10	4	25.0	1,280	5,948	1,030[30]	242[31]	661	--	793,400	--	793,400[32]	46,500
ls-19	7	43.3	2,213	10,877	1,390[33]	408[34]	1,199	--	1,291,700	--	1,291,700[35]	75,400
Unit Total	11	68.3	3,493	16,825	2,420	650	1,860	--	2,085,100	--	2,085,100	121,900

Arkansas River Basin-Kansas
Exhibit 39 - Summary of Structure Data for a Potential System
Early Action Watershed Projects

Wshd. Iden. Code No.	Upstream Floodwater Retarding Structures: No.	D.A. Controlled Sq.Mi.	Pool Capacity: Sed. Ac.Ft.	Pool Capacity: Det. Ac.Ft.	Pool Capacity: Other Ac.Ft.	Surface Area: Perm. Ac.	Surface Area: Det. Ac.	Channel Improv. Miles	Installation Costs: Struc. $	Installation Costs: Channel Improve. $	Installation Costs: Total $	Av. Ann. Costs 1/
Neosho Unit												
1t-2	9	62.2	4,311	13,798	400 2/	475 36/	1,660	--	2,156,000	--	2,156,000	122,200
1t-5	9	49.6	3,439	11,445	250 2/	417 37/	1,365	--	1,472,500	--	1,472,500	85,200
1t-7	12	64.4	4,476	14,175	245 2/	527 38/	1,868	--	1,986,600	--	1,986,600	114,800
1t-10	3	11.5	796	2,615	970 39/	176 40/	406	--	636,700	--	636,700	42,500
1t-13	7	36.4	2,521	7,954	500 2/	383 41/	1,137	--	1,262,100	--	1,262,100	76,900
1t-15	6	33.2	2,210	7,313	1,607 42/	318 43/	1,079	--	1,257,400	--	1,257,400	74,700
1t-18	2	20.3	1,406	4,977	1,480 44/	280 45/	665	--	663,600	--	663,600	44,000
1t-22	5	25.1	3,590	1,740	1,850 46/	372 47/	650	--	1,122,000	--	1,122,000	69,500
1t-23	12	104.6	8,213	24,965	964 48/	878 49/	2,787	--	2,727,600	--	2,727,600	157,700
1t-24	8	45.7	3,167	11,462	2,190 50/	688 51/	1,795	--	1,856,400	--	1,856,400	109,500
1t-25	6	25.0	1,733	6,263	1,318 52/	441 53/	1,107	--	1,224,400	--	1,224,400	73,600
1t-27	3	29.7	2,058	7,440	1,593 54/	384 55/	1,038	--	993,500	--	993,500	62,500
Subtotal	82	507.7	37,920	114,147	13,367	5,339	15,557	--	17,358,800	--	17,358,800	1,033,100
1tl-3	13	92.2	6,389	18,407	--	524	2,023	--	2,728,800	--	2,728,800	151,600
1tl-4	10	52.9	3,625	10,470	--	342	1,315	--	1,812,600	--	1,812,600	100,700
1tl-5	7	35.3	2,453	7,826	--	198 56/	759	--	990,000	--	990,000	55,000
1tl-6	3	17.3	1,199	3,717	900 2/	153 57/	426	--	817,800	--	817,800	45,000
1tl-7	11	86.6	4,150	17,306	200 2/	612 58/	2,201	--	2,370,900	--	2,370,900	135,900
1tl-8	10	125.8	7,716	29,985	876 2/	878	2,745	--	2,945,900	--	2,945,900	168,100
1tl-11	8	45.6	3,160	8,916	931 59/	409 60/	1,233	--	1,579,100	--	1,579,100	92,000
1tl-12	26	152.3	10,554	30,683	--	961	3,617	--	4,314,600	--	4,314,600	239,700
Subtotal	88	608.0	39,246	127,310	2,907	4,077	14,319	--	17,559,700	--	17,559,700	988,000
1t2-19	7	42.7	2,959	11,671	226 2/	389 61/	1,386	--	1,318,400	--	1,318,400	78,800
Unit Total	177	1,158.4	80,125	253,128	16,500	9,805	31,262	--	36,236,900	--	36,236,900	2,099,900
Basin Total	293	3,877.3	139,789	607,999	27,508	19,223	64,075	56	64,991,700	2,079,000	67,070,700	3,829,600

Footnotes

Arkansas River Basin
Exhibit 39 - Summary of Structure Data for a Potential System
Early Action Watershed Projects

1/ Amortized at 5 1/8 percent interest for 100 year period. Includes annual charge for operation and maintenance
2/ Storage for recreation
3/ Includes 53 acres for recreation
4/ Includes 158 acres for recreation
5/ For structure release flows
6/ Recreation lake
7/ Includes 195 acres for recreation
8/ Includes 90 acres for recreation
9/ Includes 225 acres for recreation
10/ Includes 173 acres for recreation
11/ Includes 183 acres for recreation
12/ Includes 198 acres for recreation
13/ Includes 113 acres for recreation
14/ Includes 98 acres for recreation
15/ Includes 188 acres for recreation
16/ Includes 120 acres for recreation
17/ Includes two structures controlling 157.0 square miles located in Colorado
18/ Includes 270 acres for recreation
19/ Includes 103 acres for recreation
20/ Includes 390 acres for recreation
21/ Includes $65,400 for multiple-purpose structure and $19,100 for channel improvement
22/ Includes 120 acres for recreation
23/ Includes $44,500 for multiple-purpose structure
24/ Includes 225 acres for recreation
25/ Includes $50,800 for multiple-purpose structure and $17,700 for channel improvement
26/ Includes 141 acres for recreation
27/ Includes $40,200 for multiple-purpose structure
28/ Includes 200 acres for recreation
29/ Includes $60,300 for multiple-purpose structure
30/ Includes 420 acre feet for recreation, 250 acre feet for municipal-industrial (City of Thayer) and 360 acre feet for rural water district
31/ Includes 157 acres for recreation
32/ Includes $26,500 for minimum basic facilities

Footnotes

Arkansas River Basin
Exhibit 39 - Summary of Structure Data for a Potential System
Early Action Watershed Projects

33/ Includes 440 acre feet for recreation and 950 acre feet for rural water district
34/ Includes 265 acres for recreation and rural water district
35/ Includes $39,600 for minimum basic facilities
36/ Includes 120 acres for recreation
37/ Includes 95 acres for recreation
38/ Includes 75 acres for recreation
39/ Includes 300 acre feet for recreation and 670 acre feet for agricultural water
40/ Includes 130 acres for recreation
41/ Includes 210 acres for recreation
42/ Includes 497 acre feet for recreation and 1,110 acre feet for municipal-industrial
43/ Includes 156 acres for water supply and recreation
44/ Includes 900 acre feet for recreation and 580 acre feet for agricultural water
45/ Includes 250 acres for recreation
46/ Includes 520 acre feet for recreation and 1,330 acre feet for agricultural water
47/ Includes 372 acres for agricultural water
48/ Includes 224 acre feet for recreation and 740 acre feet for agricultural water
49/ Includes 200 acres for agricultural water
50/ Includes 330 acre feet for recreation, 1,740 acre feet for agricultural water, and 120 acre feet for municipal-industrial
51/ Includes 352 acres for recreation and 66 acres for water supply
52/ Includes 238 acre feet for recreation and 1,080 acre feet for agricultural water
53/ Includes 315 acres for recreation
54/ Includes 493 acre feet for recreation and 1,100 acre feet for agricultural water
55/ Includes 244 acres for agricultural water
56/ Includes 95 acres for recreation
57/ Includes 84 acres for recreation
58/ Includes 210 acres for recreation
59/ Includes 191 acre feet for recreation and 740 acre feet for agricultural water
60/ Includes 134 acres for agricultural water
61/ Includes 66 acres for recreation
62/ Land treatment only

Arkansas River Basin-Kansas

Exhibit 40 - Average Annual Benefits and Benefit-Cost Ratio
Watershed Projects Authorized for Planning or Construction

(Price Base Work Plan Data)

Wshd. Iden. Code No.	Average Annual Benefits: Damage Reduction: Land Treatment $	Damage Reduction: Structural Measures $	Land Enhance-ment $	Recreation $	Off Project $	Other $	Secondary $	Total Structural Measures $	B:C Ratio	% Con-trolled	% Dam. Reduc.
Upper Arkansas Unit											
1-68	--	46,900	--	--	2,400	--	4,000	53,300	2.4:1	62	98
1-77	1,600	4,000	3,700	--	--	--	--	7,700	1.8:1	44	98
Subtotal	1,600	50,900	3,700	--	2,400	--	4,000	61,000			
1k-1	--	--	--	75,900	92,500 1/	--	18,300 2/	186,700	1.2:1	90 3/	--
1k-2	700	7,600	3,900	--	37,500 1/	9,200 4/	6,400 2/	64,600	1.6:1	37 3/	58
1k-3	100	300	200	--	126,700 5/	16,100 4/	15,500 2/	158,800	1.5:1	59	22
1k-4	5,800	23,500	8,600	--	233,000 6/	27,100 7/	30,900 2/	323,100	2.0:1	53	74
1k-5	8,200	11,800	5,600	--	52,800 8/	10,500 7/	7,900	88,600	2.2:1	23	47
Subtotal	14,800	43,200	18,300	75,900	542,500	62,900	79,000	821,800	1.6:1	50	51
Unit Total	16,400	94,100	22,000	75,900	544,900	62,900	83,000	882,800			
Lower Arkansas Unit											
1-95	1,800	34,400	14,600	--	--	--	15,300	64,300	1.6:1	43	76
1-96	2,200	21,200	14,600	--	--	--	--	35,800	2.7:1	48	79
1-100	1,000	11,200	--	34,400	1,200	--	4,400	51,200	1.8:1	75	84
Subtotal	5,000	66,800	29,200	34,400	1,200	--	19,700	151,300			
1n-4	3,700	27,200	--	--	1,400	--	4,500	33,100	1.3:1	19	56
101-7	--	6,300	--	500	--	--	600	7,400	1.0:1	19	28
Unit Total	8,700	100,300	29,200	34,900	2,600	--	24,800	191,800			

Footnotes on last page of exhibit

Arkansas River Basin-Kansas

Exhibit 40 - Average Annual Benefits and Benefit-Cost Ratio
Watershed Projects Authorized for Planning or Construction

(Price Base Work Plan Data)

Wshd. Iden. Code No.	Average Annual Benefits: Damage Reduction: Land Treatment $	Structural Measures $	Land Enhance-ment $	Recreation $	Off Project $	Other $	Secondary $	Total Structural Measures $	B:C Ratio	% Con-trolled	% Dam. Reduc.
Walnut-Verdigris Unit											
1p-1	18,100	75,100	30,100	75,000	20,800	7,800 9/	22,100	230,900	1.6:1	26	65
1p-2	21,100	70,400	29,900	--	8,600	--	12,000	120,900	1.3:1	26	72
1p-3	4,400	35,200	14,500	--	48,800	6,800 10/	9,900	115,200	1.5:1	26	66
1p-4	20,300	70,100	20,800	--	15,600	7,400 11/	11,000	124,900	1.0:1	31	72
1p-5&9	5,800	59,900	17,400	13,800	20,200	42,300 12/	13,000	166,600	1.1:1	17	46
1p-6	5,200	163,400	28,800	--	--	--	--	192,200	1.9:1	34	58
1p-7	300	14,900	1,000	--	7,600	--	2,200	25,700	2.1:1	63	63
1p-8	3,300	92,700	25,500	--	26,500	--	16,500	161,200	2.1:1	51	65
1p-10	12,500	142,100	22,400	146,200	38,800	43,800 13/	21,800	415,100	2.1:1	62	71
Subtotal	91,000	723,800	190,400	235,000	186,900	108,100	108,500	1,552,700			
1s-1	8,912	215,100	73,100	26,400	15,100	4,000 13/	39,900	373,600	1.8:1	59	56
1s-12	1,800	133,200 14/	44,200 15/	--	128,700	--	36,800	342,900	2.4:1	64	79
1s-13	6,300	113,500	21,400	--	39,700	--	19,500	194,100	2.1:1	51	71
1s-14	1,700	32,700	4,700	--	5,900	--	3,900	47,200	1.0:1	43	52
Subtotal	18,712	494,500	143,400	26,400	189,400	4,000	100,100	957,800			
1sl-1	3,475	195,400	14,200	--	--	13,000 16/	--	222,600	1.3:1	47	62
1s2-1	26,700	223,100	25,500	24,300	--	--	26,000	298,900	2.0:1	51	79
1s2-2	2,700	22,100	2,300	1,600	--	--	2,500	28,500	1.5:1	29	83
1s2-3	7,900	101,500	24,400	--	58,500	2,300 17/	--	186,700	2.0:1	69	71
1s2-4	4,200	208,900	20,400	--	--	10,000 18/	--	239,300	1.7:1	54	66
1s2-5	6,200	88,700	14,300	--	--	--	--	103,000	3.3:1	40	69
Subtotal	47,700	644,300	86,900	25,900	58,500	12,300	28,500	856,400			
Unit Total	160,887	2,058,000	434,900	287,300	434,800	137,400	237,100	3,589,500			

Arkansas River Basin-Kansas

Exhibit 40 - Average Annual Benefits and Benefit-Cost Ratio

Watershed Projects Authorized for Planning or Construction

(Price Base Work Plan Data)

Wshd. Iden. Code No.	Average Annual Benefits								B:C Ratio	% Con-trolled	% Dam. Reduc.
	Damage Reduction		Land Enhance-ment $	Recreation $	Off Project $	Other $	Secondary $	Total Structural Measures $			
	Land Treatment $	Structural Measures $									
Neosho Unit											
1t-8	1,300	55,300	13,900	--	7,100	--	10,300	86,600	1.2:1	31	53
1t1-9	--	17,100	3,300	--	--	--	--	20,400	1.2:1	57	76
Unit Total	1,300	72,400	17,200	--	7,100	--	10,300	107,000			
Basin Total	187,287	2,324,800	503,300	398,100	989,400	200,300	355,200	4,771,100			

1/ Includes benefits from watersheds 1k-3, 1k-4, 1k-5, and 1k-6
2/ Includes secondary benefits to off-project benefits
3/ Contributing drainage area only
4/ Includes incidental recreation and sediment storage benefits
5/ Includes benefits from watersheds 1k-4, 1k-5, and 1k-6
6/ Includes benefits from watersheds 1k-5 and 1k-6
7/ Includes incidental recreation, sediment storage, and groundwater recharge benefits
8/ Includes benefits from watershed 1k-6
9/ Includes benefits to Towanda Reservoir
10/ Includes $6,800 benefit, on project, to mainstem Walnut River
11/ Includes benefits to El Dorado Reservoir
12/ Includes benefits to municipal water of $18,900 and EDA benefits to labor of $23,400
13/ Includes benefits to municipal water
14/ Additional damage reduction benefits of $62,300 accrue to structural measures in Upper Elk River Watershed
15/ Additional benefits of $8,600 more intensive use and $6,200 changed land use accrue to structural measures in Upper Elk River Watershed
16/ Includes benefits to municipal water supply - city of Eureka
17/ Municipal water supply - city of Sedan
18/ Includes benefits to non-agricultural water management

Arkansas River Basin-Kansas
Exhibit 41 - Average Annual Benefits and Benefit-Cost Ratio
Early Action Watershed Projects

(Price Base Adjusted Normalized Prices)

Wshd. Iden. Code No.	Average Annual Benefits: Damage Reduction: Land Treatment $	Damage Reduction: Structural Measures $	Land Enhance-ment $	Recreation $	Off Project $	Other $	Secondary $	Total Structural Measures $	B:C Ratio	% Con-trolled	% Damage Reduc-tion
Upper Arkansas Unit											
1-61	5,100	14,100	1,300	4,000	--	--	1,700	21,100	1.2:1	25	65
1-65	57,300	232,800	49,200	21,900	--	--	27,400	331,300	2.2:1	79	86
1-85	1,800	8,700	1,700	2,700	--	--	1,200	14,300	1.4:1	53	63
1-87	14,000	80,700	21,400	14,600	--	--	11,700	128,400	1.1:1	59	74
1-89	11,800	74,700	9,900	6,800	--	--	8,200	99,600	1.5:1	26	74
Subtotal	90,000	411,000	83,500	50,000	--	--	50,200	594,700			
1j-1	5,500	17,600	3,400	16,900	53,200	--	8,200	99,300	1.1:1	54	72
1j-2	7,600	9,500	2,800	13,000	15,500	--	3,700	44,500	0.8:1 1/	29	71
1j-3	1,900	3,700	1,000	13,700	6,800	--	2,300	27,500	1.3:1	28	62
1j-4	2,600	7,000	2,000	14,900	11,000	--	3,100	38,000	1.0:1	43	92
1j-5	11,400	13,100	4,000	8,500	3,600	--	2,600	31,800	0.9:1 1/	21	61
1j-6	28,300	56,400	11,500	7,400	--	--	6,800	82,100	1.2:1	23	50
Subtotal	57,300	107,300	24,700	74,400	90,100	--	26,700	323,200			
1jl-1	1,100	--	--	--	--	--	--	--	--	--	17
1jl-2	3,500	17,300	6,100	14,100	11,900	--	4,400	53,800	1.0:1	39	66
1jl-3	9,800	26,200	6,400	9,600	3,700	--	4,100	50,000	1.5:1	33	77
Subtotal	14,400	43,500	12,500	23,700	15,600	--	8,500	103,800			
1i-2	--	--	--	--	100,900 3/	--	11,900	112,800	0.8:1 2/	--	--
1i-3	4,400	4,200	1,500	20,300	73,000 4/	--	8,900	107,900	1.6:1	73	59
1i-4	41,100	23,200	4,500	--	7,500 5/	--	3,200	38,400	1.7:1	36	72
1i-5	17,800	--	--	--	--	--	--	--	--	--	62
Subtotal	63,300	27,400	6,000	20,300	181,400	--	24,000	259,100			
1k-6	3,100	22,600	7,600	7,900	--	11,600	3,400	53,100	1.2:1	35	59
Unit Total	228,100	611,800	134,300	176,300	287,100	11,600	112,800	1,333,900			

Footnotes on last page of exhibit

Exhibit 41 - Average Annual Benefits and Benefit-Cost Ratio
Early Action Watershed Projects

(Price Base Adjusted Normalized Prices)

Wshd. Iden. Code No.	Average Annual Benefits: Damage Reduction: Land Treatment $	Damage Reduction: Structural Measures $	Land Enhancement $	Recreation $	Off Project $	Other $	Secondary $	Total Structural Measures $	B:C Ratio	% Controlled	% Damage Reduction
Lower Arkansas Unit											
1m-1	5,600	54,700 6/	6,100 7/	73,300	--	--	12,100	146,200	1.4:1	31	67
1m-2	4,200	21,100	5,800	22,600	53,100	--	9,200	111,800	1.0:1	31	38
1m-3	8,200	20,500	2,600	42,300	3,500	--	6,200	75,100	1.1:1	7	21
Subtotal	18,000	96,300	14,500	138,200	56,600	--	27,500	333,100			
1n-1	14,900	121,600	18,800	26,500	43,200	--	18,900	229,000	1.2:1	44	57
1q2-6	6,100	41,300	4,700	45,100	17,000	--	9,700	117,800	1.2:1	38	62
Unit Total	39,000	259,200	38,000	209,800	116,800	--	56,100	679,900			
Walnut-Verdigris Unit											
1s-10	1,100	17,900	1,300	18,400	5,600	2,600	4,100	49,900	1.1:1	43	56
1s-19	3,300	48,000	3,000	21,600	8,500	3,500	7,600	92,200	1.2:1	37	44
Unit Total	4,400	65,900	4,300	40,000	14,100	6,100	11,700	142,100			

Arkansas River Basin-Kansas
Exhibit 41 - Average Annual Benefits and Benefit-Cost Ratio
Early Action Watershed Projects

(Price Base Adjusted Normalized Prices)

Wshd. Iden. Code No.	Average Annual Benefits: Damage Reduction: Land Treatment $	Damage Reduction: Structural Measures $	Land Enhancement $	Recreation $	Off Project $	Other $	Secondary $	Total Structural Measures $	B:C Ratio	% Controlled	% Damage Reduction
Neosho Unit											
1t-2	4,500	101,800	12,300	22,600	7,200	--	13,000	156,900	1.3:1	48	52
1t-5	3,700	63,500	10,600	17,900	5,800	--	8,800	106,600	1.3:1	40	42
1t-7	6,600	114,200	18,100	14,100	6,600	--	13,800	166,800	1.5:1	32	48
1t-10	1,000	18,900	4,400	24,400	1,200	4,800 8/	4,800	58,500	1.4:1	20	35
1t-13	4,300	56,400	7,400	39,500	3,700	--	9,600	116,600	1.5:1	31	41
1t-15	2,600	36,000	8,100	29,300	3,400	6,100 9/	7,500	90,400	1.2:1	22	25
1t-18	2,400	23,400	4,600	47,000	2,200	1,400 8/	7,100	85,700	2.0:1	24	32
1t-22	2,300	18,900	3,800	69,900	2,900	21,600 10/	10,500	127,600	1.8:1	20	32
1t-23	7,400	93,600	22,700	37,600	12,100	39,600 11/	18,500	224,100	1.4:1	41	52
1t-24	6,300	48,900	11,900	66,200	14,100	14,700 12/	14,000	169,800	1.6:1	19	27
1t-25	6,700	36,100	7,000	81,200	2,900	24,300 13/	13,600	165,100	2.2:1	21	28
1t-27	1,700	22,600	6,400	45,900	3,400	18,900 14/	8,700	105,900	1.7:1	48	62
Subtotal	49,500	634,300	117,300	495,600	65,500	131,400	129,900	1,574,000			
1tl-3	2,400	103,500	4,200	--	56,000	19,900 15/	18,300	201,900	1.3:1	61	71
1tl-4	1,900	64,000	2,700	--	36,600	11,400 15/	11,500	126,200	1.3:1	46	55
1tl-5	800	35,300	11,800	--	28,400	--	7,600	83,100	1.5:1	40	45
1tl-6	900	45,600	6,100	17,900	2,000	--	6,400	78,000	1.7:1	44	54
1tl-7	13,100	104,900	17,900	15,800	10,000	--	13,400	162,000	1.2:1	29	33
1tl-8	3,600	143,300	22,900	39,500	14,600	--	19,800	240,100	1.4:1	54	40 16/
1tl-11	10,800	59,000	8,400	25,200	3,000	3,100 17/	8,900	107,600	1.2:1	34	15 16/
1tl-12	2,000	136,300	18,200	--	138,300	--	29,300	322,100	1.3:1	54	69
Subtotal	35,500	691,900	92,200	98,400	288,900	34,400	115,200	1,321,000			
1t2-19 Unit	7,800	49,800	9,800	12,400	5,000	17,300 17/	8,500	102,800	1.3:1	17	28
Total	92,800	1,376,000	219,300	606,400	359,400	183,100	253,600	2,997,800			
Basin Total	364,300	2,312,900	395,900	1,032,500	777,400	200,800	434,200	3,153,700			

Footnotes

Arkansas River Basin

Exhibit 41 - Average Annual Benefits and Benefit-Cost Ratio

Early Action Watershed Projects

1/ Part of Pawnee River Watershed District - groundwater recharge benefits and projected irrigation on the floodplain are expected to bring these above unity

2/ Part of the Whitewoman Creek drainage area - groundwater recharge benefits and projected irrigation on the floodplain are expected to bring this above unity

3/ Includes benefits in watersheds li-3, li-4, and li-5

4/ Includes benefits in watersheds li-4 and li-5

5/ Includes benefits in watershed li-5

6/ Includes $12,900 accruing to channel improvement

7/ Includes $1,000 accruing to channel improvement

8/ Benefits to agricultural water

9/ Benefits to municipal and industrial water supply

10/ Includes $6,500 agricultural water and $15,100 EDA benefits to local labor

11/ Includes $5,300 agricultural water and $34,300 EDA benefits to local labor

12/ Includes $9,600 benefit to agricultural water and $5,100 benefit to water supply

13/ Includes $7,100 agricultural water and $17,200 EDA benefits to local labor

14/ Includes $5,400 agricultural water and $13,500 EDA benefits to local labor

15/ Sediment reduction to John Redmond Reservoir

16/ Damage reduction influenced by damages included from mainstem Cottonwood River

17/ Benefits to agricultural water

Arkansas River Basin-Kansas

Exhibit 42 - 1964 and Projected Employment in Timber-Based Industries

Number of Employees by Type of Manufacturing

Planning Units	Timber Harvesting	Sawmills and Planing Mills	Pulp, Paper and Allied Products	Other 1/	Total
			1964		
Cimarron	0	0	0	0	0
Upper Arkansas	0	0	0	0	0
Lower Arkansas	10	20	150	580	760
Walnut-Verdigris	42	35	0	165	242
Neosho	68	72	0	140	280
Total	120	127	150	885	1,282
			1980		
Cimarron	0	0	0	10	10
Upper Arkansas	5	10	0	10	25
Lower Arkansas	15	30	180	630	855
Walnut-Verdigris	50	40	0	220	310
Neosho	80	80	0	185	345
Total	150	160	180	1,055	1,545
			2000		
Cimarron	0	10	0	30	40
Upper Arkansas	10	25	40	30	105
Lower Arkansas	20	50	300	750	1,120
Walnut-Verdigris	65	55	100	350	570
Neosho	100	90	100	300	590
Total	195	230	540	1,460	2,425
			2020		
Cimarron	0	10	10	40	60
Upper Arkansas	10	35	50	50	145
Lower Arkansas	20	35	400	850	1,305
Walnut-Verdigris	75	65	150	450	740
Neosho	110	100	200	400	810
Total	215	245	810	1,790	3,060

1/ Cooperage mills, veneer mills, shingle mills, plywood mills, and manufactured articles made entirely or mainly of wood

Source: Estimates by USDA Forest Service and Kansas State Forest Service

Arkansas River Basin-Kansas

Exhibit 43 - 1964 and Projected Timber Cut, Growth and Inventory of Sawtimber and Sawtimber in Growing Stock on Commercial Forest Land

	Cut (M board feet)	Growth (M board feet)	Inventory (M board feet)
Planning Units	All Species	All Species	All Species
		1964	
Cimarron	0	0	13
Upper Arkansas	0	0	18
Lower Arkansas	1	3	107
Walnut Verdigris	3	5	225
Neosho	5	8	308
Total	9	16	671
		1980	
Cimarron	0	0	14
Upper Arkansas	0	1	21
Lower Arkansas	1	3	110
Walnut-Verdigris	7	6	227
Neosho	10	9	316
Total	18	19	688
		2000	
Cimarron	0	0	14
Upper Arkansas	0	1	20
Lower Arkansas	1	4	108
Walnut-Verdigris	10	7	223
Neosho	15	11	311
Total	26	23	676
		2020	
Cimarron	0	1	13
Upper Arkansas	0	1	20
Lower Arkansas	2	4	103
Walnut-Verdigris	11	9	213
Neosho	16	13	297
Total	29	28	646

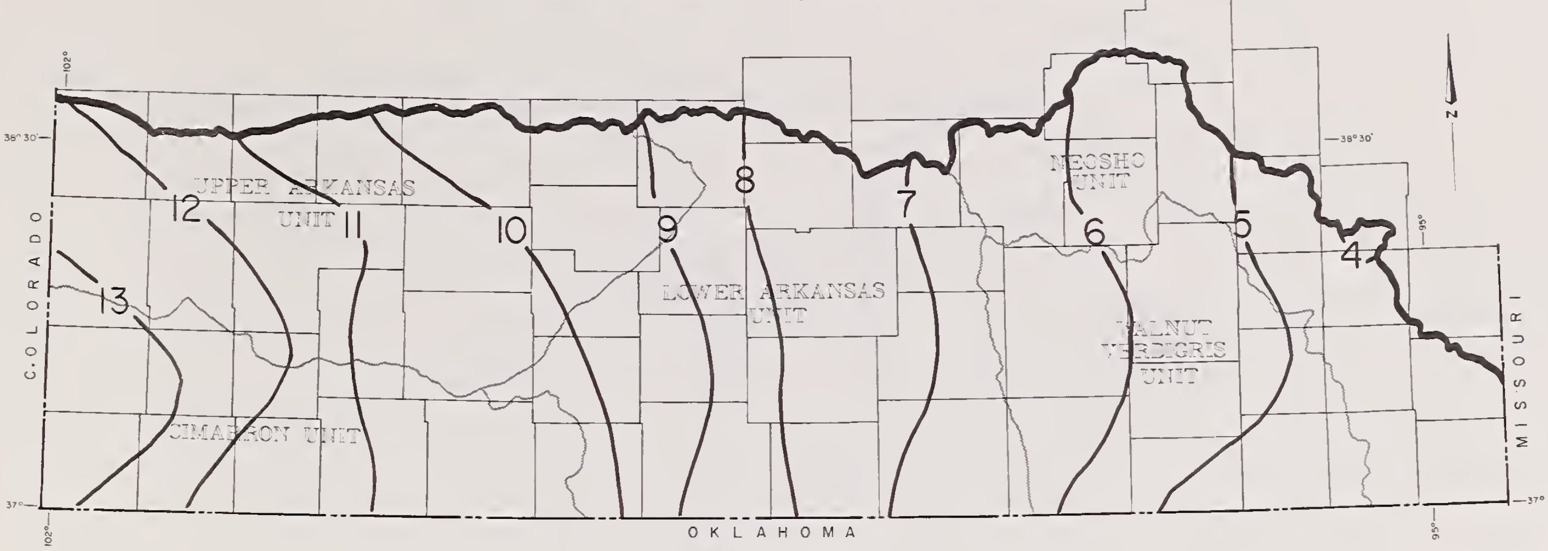
Source: Estimated by USDA Forest Service and Kansas State Forest Service

Arkansas River Basin-Kansas
Exhibit 44 - Land Treatment and Structural Measures
Proposed by 1980 for the Cimarron National Grassland
(Morton and Stevens Counties, Kansas)

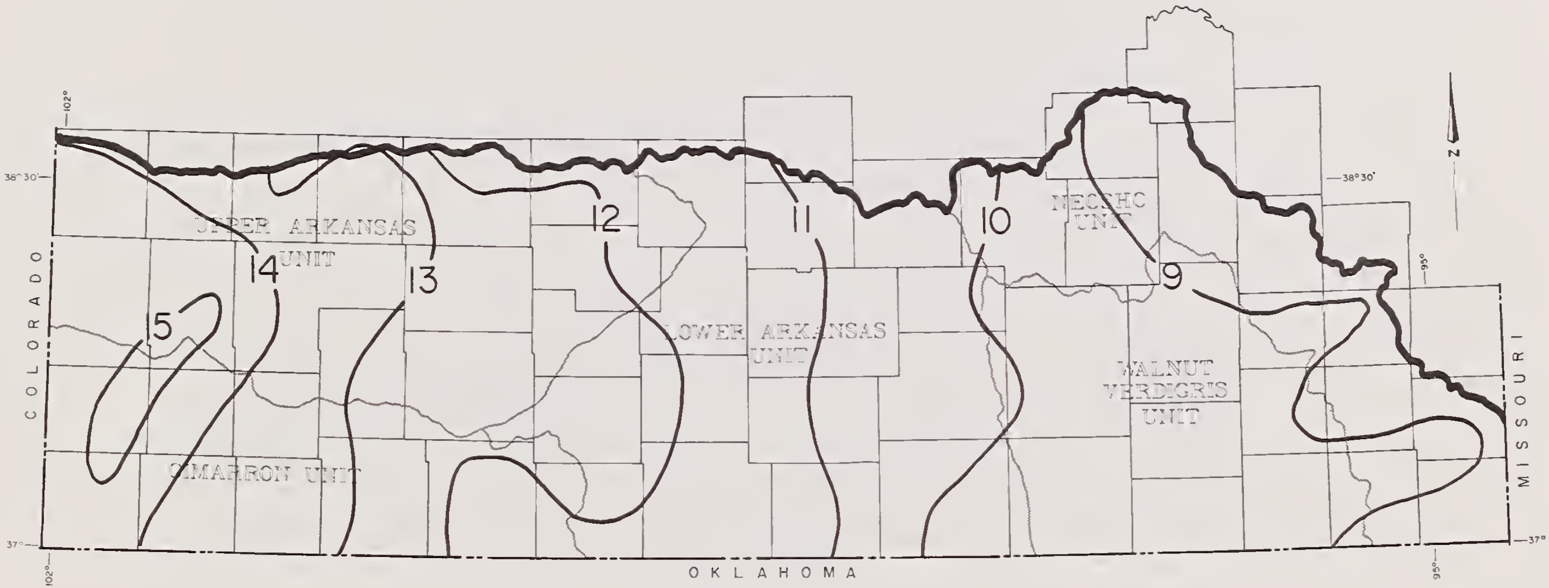
Item	Unit	Amount
Range Revegation (Plant control and type conversion)	Acres	37,200
Range Corrals	Each	30
Range Fences	Miles	37
Range Water Developments	Each	40
Wildlife Shallow Water Impoundments	Acres	35
Wildlife Seeding and Planting	Acres	25
Wildlife Restoration Areas	Miles	5
Wildlife Water Facilities	Each	200
Road Construction	Miles	1
Erosion Control - Gully	Miles	90
- Blowouts	Acres	990
- Roads and Trail	Miles	130
- Flow Regulation Structures	Each	172
Water Storage Structures	Each	2
Recreation Sites (Stand Improvement)	Acres	31

Exhibit No. 45

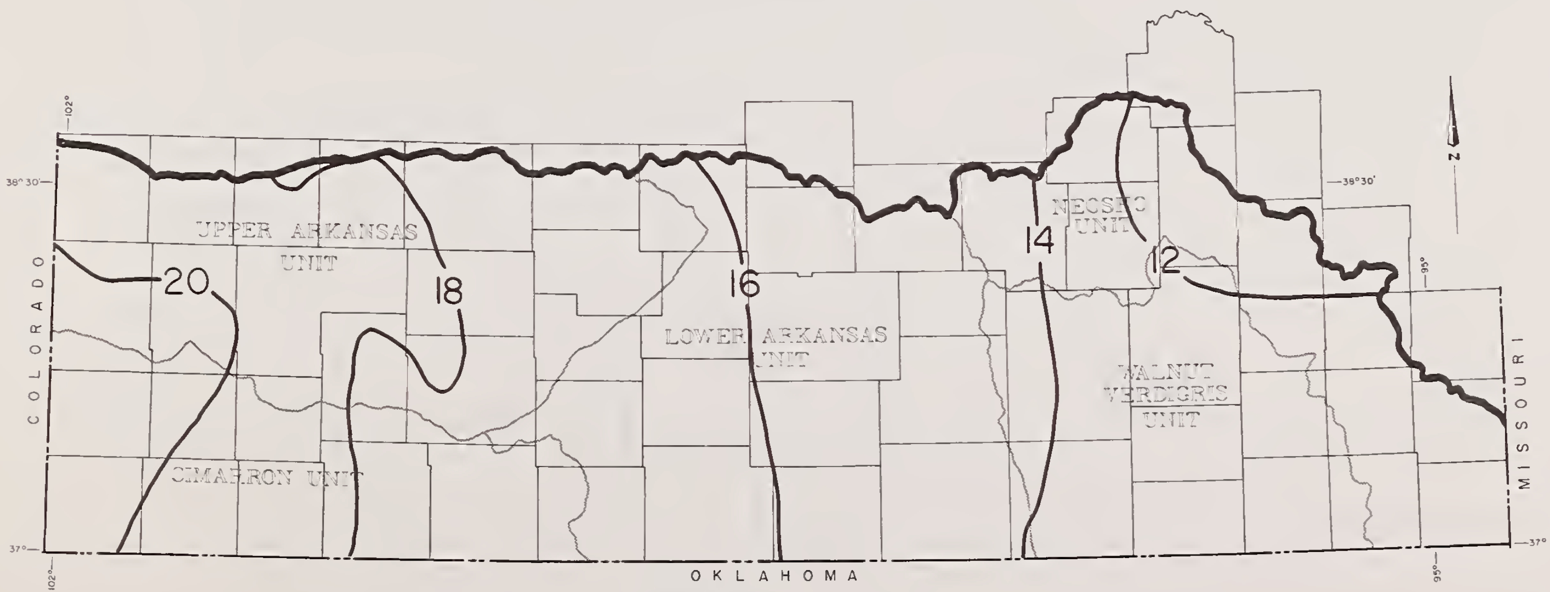
AVERAGE NET IRRIGATION REQUIREMENTS FOR THE GROWING SEASON (value in inches)



WHEAT



SOYBEANS



SUGAR BEETS

SCALE 20 0 20 40 60 MILES

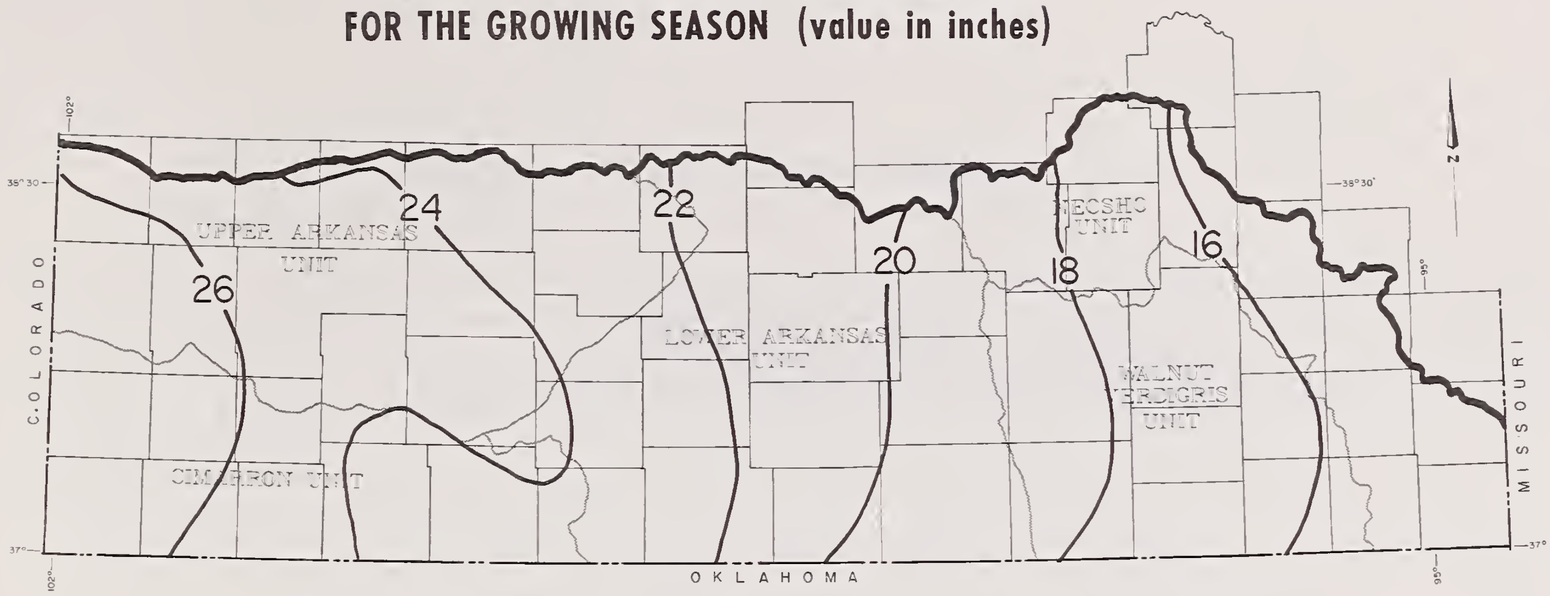
SCALE 1/3,870,000

EXHIBIT NO. 45

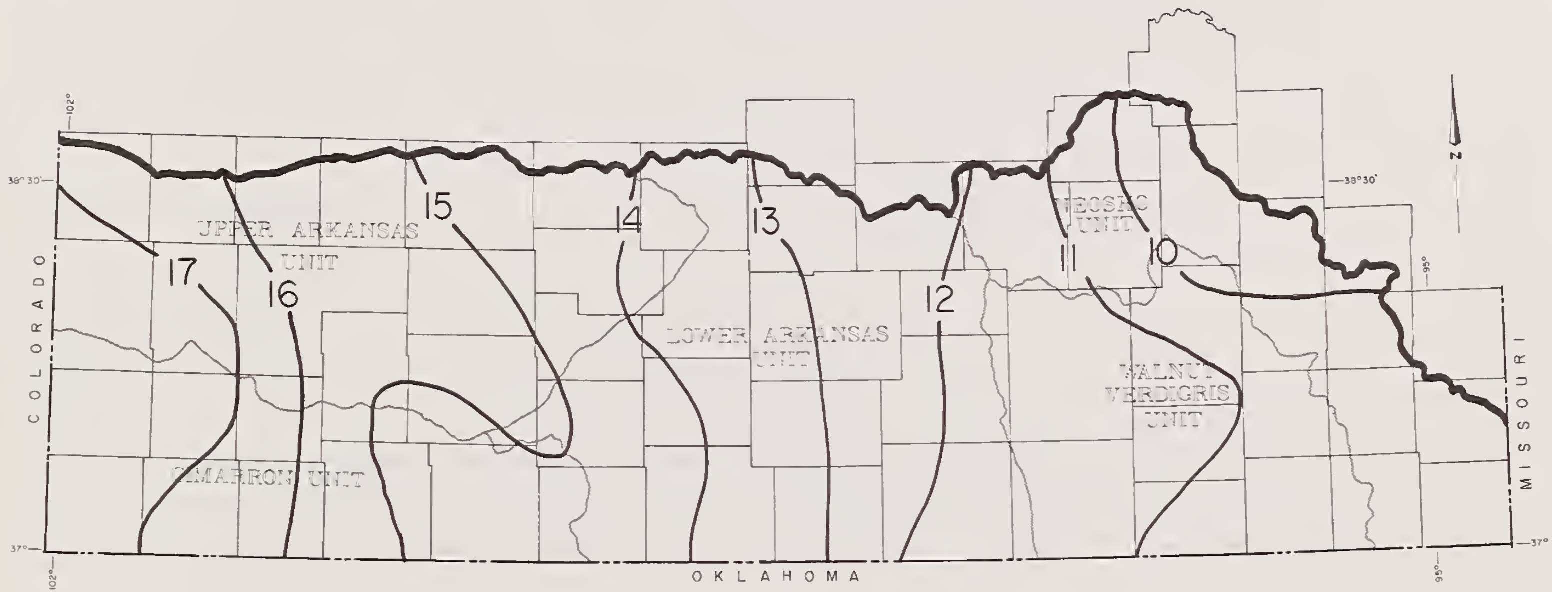
2-16-71
5,S-28617.6

Exhibit No. 45

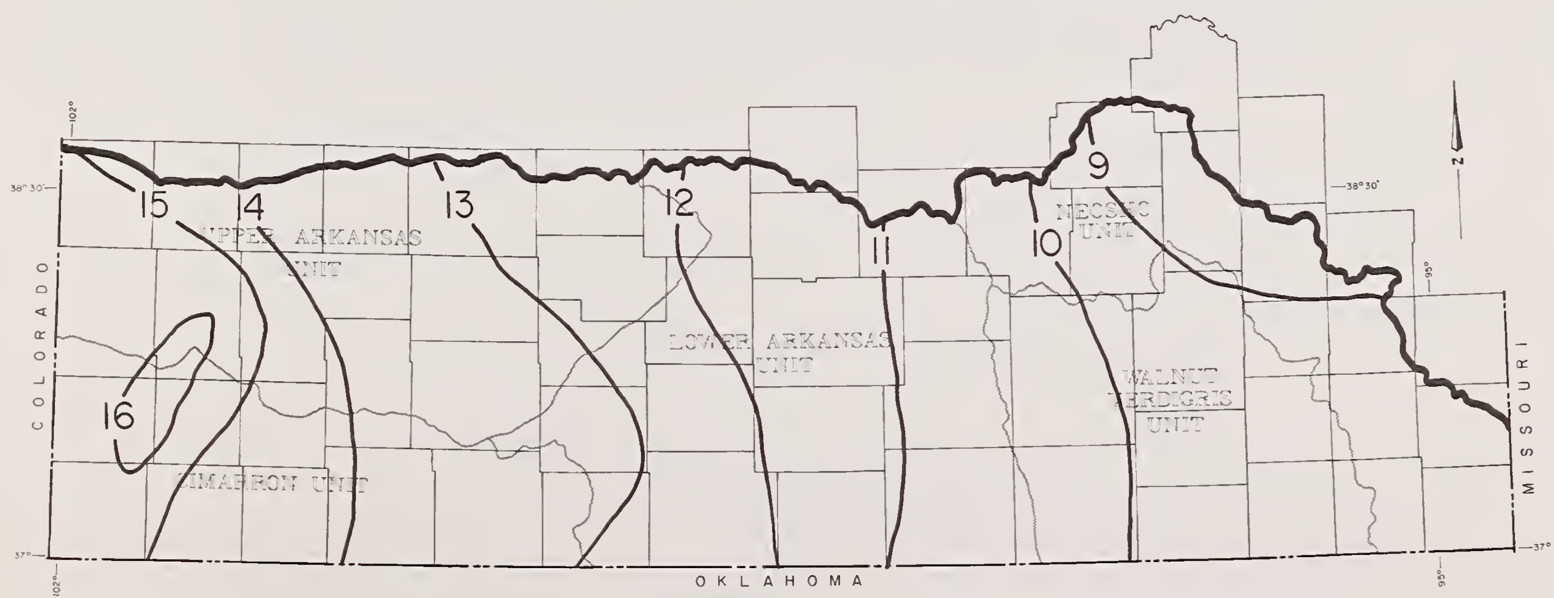
AVERAGE NET IRRIGATION REQUIREMENTS FOR THE GROWING SEASON (value in inches)



ALFALFA



CORN



SORGHUM

SCALE 20 0 20 40 60 MILES

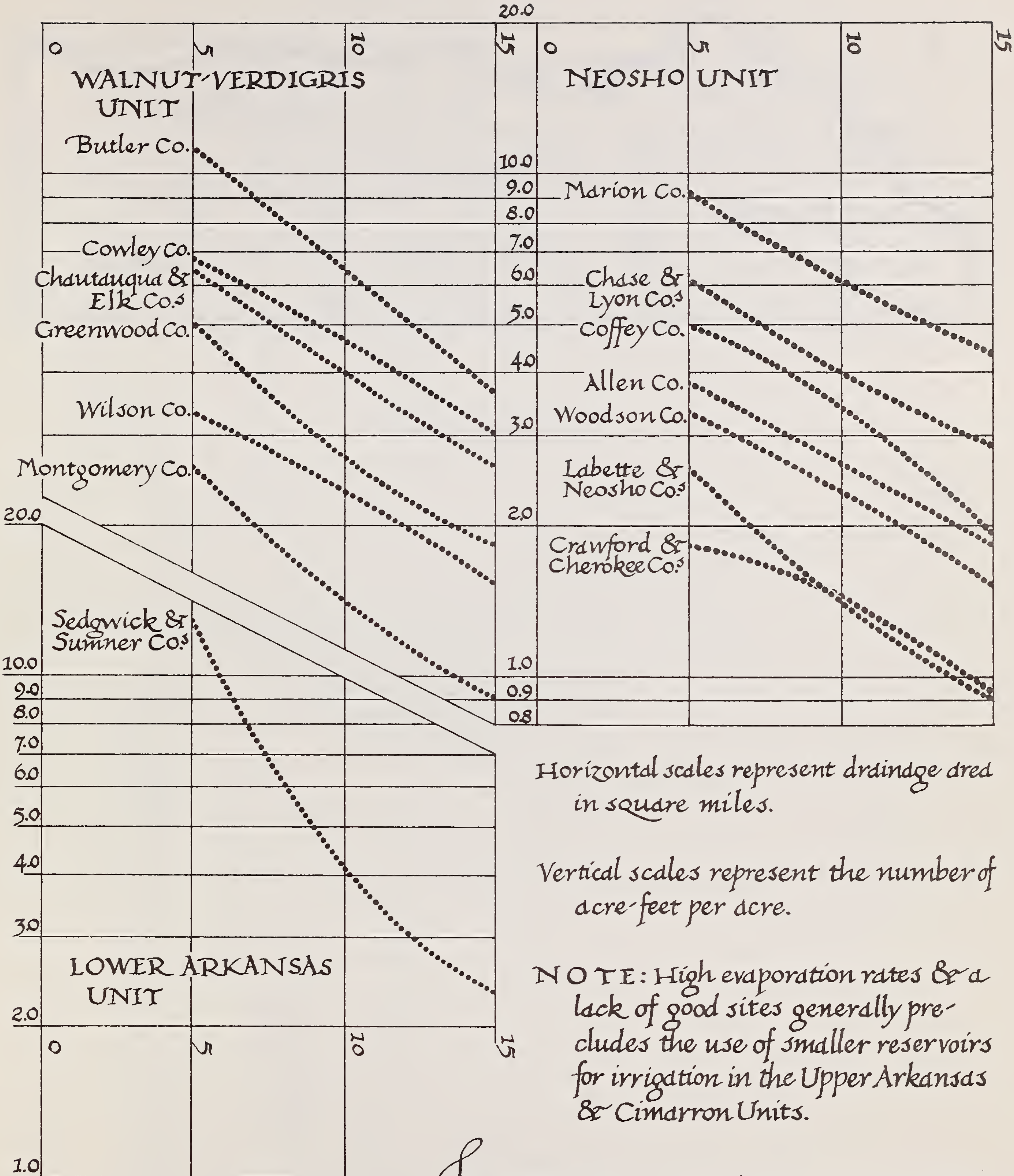
SCALE 1/3,870,000

Arkansas River Basin-Kansas
Exhibit 46 - Number of Primary Wood-Using Plants

Kind of Mill	Number of Plants by Planning Unit					
	Cimarron	Upper Arkansas	Lower Arkansas	Walnut-Verdigris	Neosho	All Units
Sawmills:						
Small[1/]	0	0	6	8	14	28
Medium[2/]	0	0	0	1	1	2
Coperage Mills	0	0	0	1	2	3
Charcoal Plants	0	0	1	0	1	2
Miscellaneous Plants[3/]	0	0	1	3	3	7
GRAND TOTAL	0	0	8	13	21	42

1/ Annual lumber output less than 1 million board feet.
2/ Annual lumber output from 1 million to 5 million feet.
3/ Includes: Fence post concentration yards, treating plant.

Source: 1964 Inventory by USDA Forest Service and Kansas State Forest Service



Horizontal scales represent drainage area in square miles.

Vertical scales represent the number of acre-feet per acre.

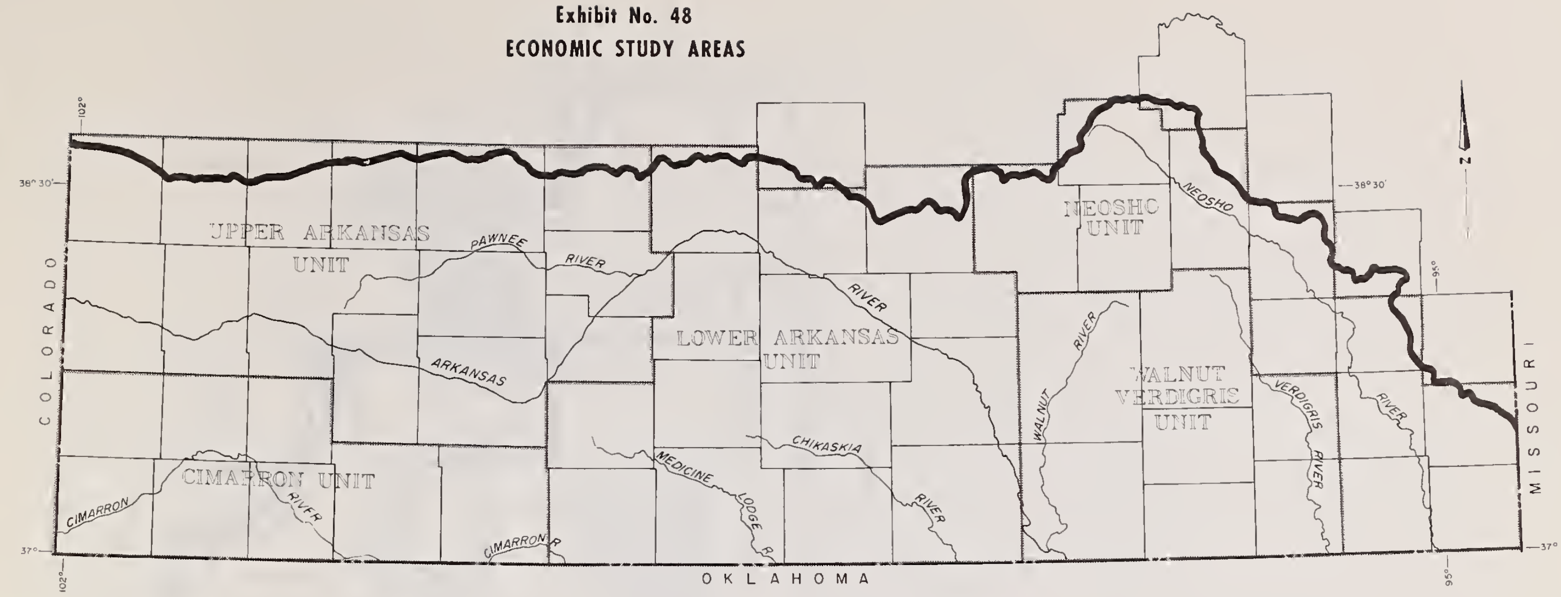
NOTE: High evaporation rates & a lack of good sites generally precludes the use of smaller reservoirs for irrigation in the Upper Arkansas & Cimarron Units.

RESERVOIR-STORAGE-REQUIRED PER-ACRE-OF-IRRIGATION

Source: Kansas Water Resources Board

Exhibit 47

Exhibit No. 48
ECONOMIC STUDY AREAS



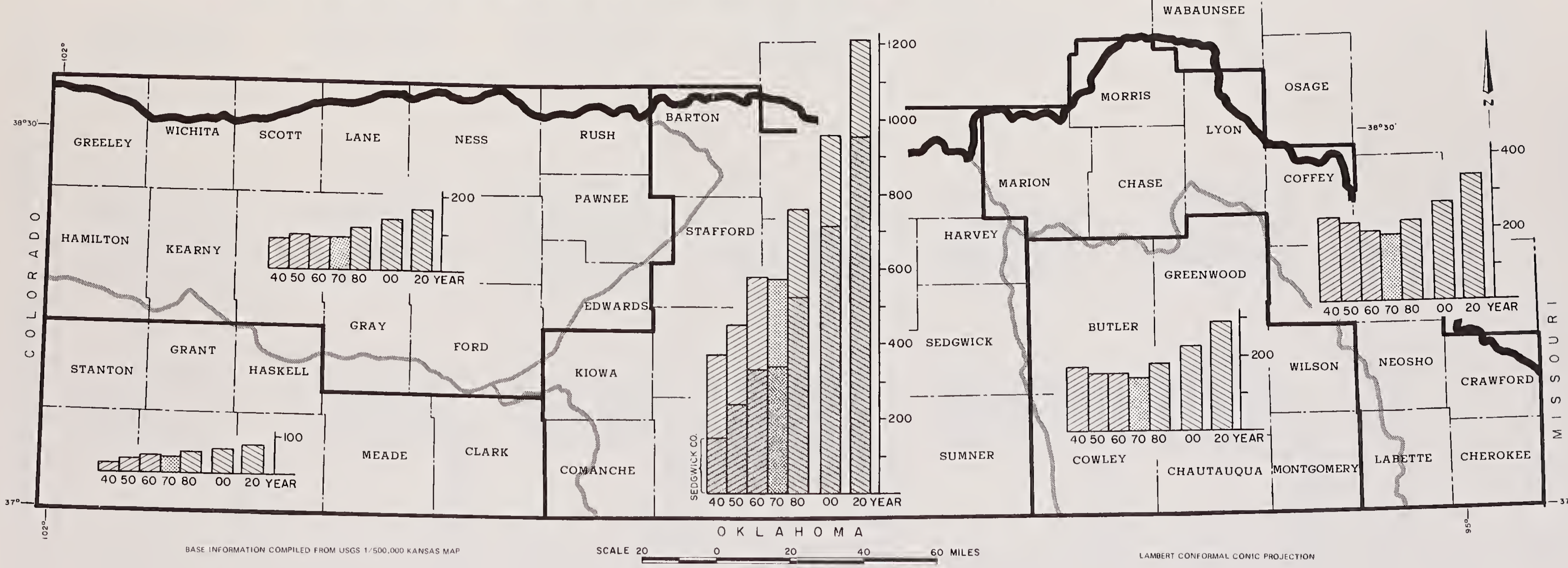
SCALE 20 0 20 40 60 MILES
SCALE 1/3,870,000

USDA SCS-LINCOLN NEBR 1973

1-29-73
5,0-31,153

EXHIBIT NO. 49

HISTORIC AND PROJECTED POPULATION BY UNITS AND FOR SEDGWICK COUNTY



BASE INFORMATION COMPILED FROM USGS 1/500,000 KANSAS MAP

SCALE 1/2,930,000

LAMBERT CONFORMAL CONIC PROJECTION

POPULATION IN THOUSANOS

1970 FIGURES ARE PRELIMINARY ANO SUBJECT TO REVISION

12-3-70
5,0-28,616.1

USDA-SCS-LINCOLN, NEBR 1972

Arkansas River Basin-Kansas
Exhibit 50 - Urban and Rural Farm and Non-farm Population
1930, 1940, 1950, 1960, and 1970

Year	Urban	Rural			Total
		Farm	Non-farm	Total	
		Arkansas River Basin			
1930	378,054	326,642	222,174	548,816	926,870
1940	385,246	283,132	217,246	500,378	885,624
1950	498,439	210,383	233,469	443,852	942,291
1960	658,299	150,347	250,684	401,031	1,059,330
1970	660,857	112,411	267,072	379,483	1,040,340
		Upper Arkansas Area			
1930	19,712	46,318	29,418	75,736	95,448
1940	18,305	36,456	28,306	64,762	83,067
1950	29,818	29,525	33,720	63,245	93,063
1960	33,887	22,918	34,115	57,033	90,920
1970	37,403	17,598	35,884	53,482	90,885
		Cimarron Area			
1930	5,294	18,168	13,063	31,231	36,525
1940	4,410	11,830	10,759	22,589	26,999
1950	9,915	9,932	16,414	26,346	36,261
1960	19,882	7,468	15,602	23,070	42,952
1970	19,989	6,052	17,205	23,257	43,246
		Lower Arkansas Area			
1930	186,290	108,812	66,977	175,789	362,079
1940	200,404	98,740	76,083	174,823	375,227
1950	292,954	71,514	85,149	156,663	449,617
1960	432,328	53,118	94,265	147,383	579,711
1970	432,311	41,261	102,999	144,260	576,571
		Walnut-Verdigris Area			
1930	84,238	59,725	41,698	101,423	185,661
1940	81,561	53,363	36,588	89,951	171,512
1950	83,901	38,610	34,326	72,936	156,837
1960	89,287	25,073	42,237	67,310	156,597
1970	80,929	17,178	44,470	61,648	142,577
		Neosho Area			
1930	82,520	93,619	71,018	164,637	247,157
1940	80,566	82,743	65,510	148,253	228,819
1950	81,851	60,802	63,860	124,662	206,513
1960	82,915	41,770	64,465	106,235	189,150
1970	90,225	30,322	66,514	96,836	187,061

Source: Bureau of Census, and Kansas Statistical Abstract, 1966

Arkansas River Basin-Kansas
Exhibit 51 - Net Migration
1960-1970

Study Area	Net Migration 1960-1970	Migration Rate 1960-1970
	Number	Percent
Upper Arkansas		
Edwards	-655	-12.8
Finney	+3	+0.02
Ford	-670	-3.2
Gray	-215	-4.9
Greeley	-463	-22.2
Hamilton	-697	-22.2
Hodgeman	-655	-21.0
Kearny	-341	-11.0
Lane	-661	-21.6
Ness	-897	-16.4
Pawnee	-2,076	-20.2
Rush	-1,150	-18.7
Scott	-320	-6.1
Wichita	+19	+0.7
Total	-8,778	
Lower Arkansas		
Barber	-1,933	-22.2
Barton	-5,048	-15.6
Comanche	-635	-19.4
Harper	-1,667	-17.5
Harvey	-497	-1.9
Kingman	-1,378	-13.8
Kiowa	-558	-12.1
McPherson	-581	-2.0
Pratt	-2,459	-20.3
Reno	-3,362	-5.7
Rice	-1,956	-14.1
Sedgwick	-44,042	-12.8
Stafford	-1,449	-19.4
Sumner	-2,538	-10.0
Total	-68,103	

Study Area	Net Migration 1960-1970	Migration Rat 1960-1970
	Number	Percent
Cimarron		
Clark	-557	-16.4
Grant	-229	-4.3
Haskell	+209	+7.0
Meade	-968	-17.6
Morton	-191	-5.7
Seward	-2,770	-17.4
Stanton	-227	-10.8
Stevens	-695	-15.8
Total	-5,428	
Walnut-Verdigris		
Butler	-2,641	-6.9
Chautauqua	-1,049	-17.6
Cowley	-3,968	-10.5
Elk	-796	-15.8
Greenwood	-1,976	-17.6
Montgomery	-6,544	-14.5
Wilson	-1,583	-12.1
Total	-18,557	
Neosho		
Allen	-1,368	-8.4
Chase	-480	-12.2
Cherokee	-1,065	-4.8
Coffey	-799	-9.5
Crawford	+763	+2.1
Labette	-1,443	-5.4
Lyon	+3,041	+11.3
Marion	-1,516	-10.0
Morris	-976	-13.2
Neosho	-1,092	-5.6
Woodson	-448	-8.3
Total	-5,383	

Study Area Total - 106,249

Source: Population Change and Net Migration by Counties in the Great Plains States, 1960-1970, Great Plains Agricultural Council Publication No. 52, June 1971

Arkansas River Basin-Kansas
Exhibit 52 - Population, Civilian Labor Force and Unemployment
(Persons 16 years old and older)
1970

Area	Male				Female				Total			
	Population	Labor Force	Participation	Unemployed	Population	Labor Force	Participation	Unemployed	Population	Labor Force	Participation	Unemployed
	No.	No.	Pct.	Pct.	No.	No.	Pct.	Pct.	No.	No.	Pct.	Pct.
United States	67,235 1/	49,549 1/	73.7	3.9	73,852 1/	30,502 1/	41.3	5.2	141,087 1/	80,051 1/	56.7	4.4
Arkansas River Basin	349,019	264,756	75.8	4.4	386,830	153,190	39.6	6.0	735,849	417,946	56.8	5.0
Upper Arkansas	30,335	23,954	79.0	2.4	32,151	12,301	37.1	4.5	62,486	36,255	58.0	3.1
Cimarron	14,333	11,915	83.1	2.4	14,636	5,639	38.5	3.0	28,969	17,554	60.6	2.6
Lower Arkansas	190,187	147,735	77.7	5.1	210,850	88,961	42.2	6.6	401,037	236,696	59.0	5.6
Walnut-Verdigris	48,621	35,525	73.1	4.5	55,506	20,097	36.2	5.2	104,127	55,622	53.4	4.8
Neosho	65,543	45,627	69.6	3.4	73,687	26,192	35.5	6.1	139,230	71,819	51.6	4.3

1/ Number in thousands

Source: Bureau of the Census

Arkansas River Basin-Kansas
Exhibit 53 - Weeks Worked
(Persons 16 Years Old and Older)
1969

Area	Persons Who Worked		Number of Weeks Worked		
			50-52	27-49	26 or less
	No.	Pct.[1/]	Pct.	Pct.	Pct.
United States	92,410[2/]	65.5	58.0	22.9	19.1
Arkansas River Basin	484,270	65.8	59.7	20.9	19.4
Upper Arkansas	41,579	66.5	62.4	18.3	19.3
Cimarron	20,183	69.7	61.7	18.7	19.6
Lower Arkansas	274,072	68.3	59.9	21.3	18.8
Walnut-Verdigris	63,413	60.9	60.6	21.0	18.4
Neosho	85,023	61.1	56.4	21.4	22.2

1/ Percent of persons 16 years old and older who worked

2/ Thousands of workers

Source: Bureau of the Census

Arkansas River Basin-Kansas
Exhibit 54 - Employment by Industry and
Percentage Change in Employment
1940, 1950, 1960, and 1970

Industry	Employment				Percentage Change		
	1940	1950	1960	1970	40-50	50-60	60-70
Agriculture	86,118	75,141	48,823	36,278	-12.7	-35.0	-25.6
Agriculture, Forestry & Fisheries	86,118	75,141	48,823	36,278	-12.7	-35.0	-25.6
Manufacturing	24,619	47,538	75,364	80,385	93.1	58.5	6.7
Food and kindred products	7,152	8,997	10,623	8,683	25.8	18.1	-18.3
Textile mill products, apparel	581	1,218	1,908	2,402	109.6	56.7	25.9
Lumber, Wood, Products, Furniture	725	1,018	789	1,404	40.4	-22.5	77.9
Printing and publishing	3,419	4,077	5,429	5,173	19.3	33.2	-4.7
Chemicals and allied products	1,202	2,146	2,761	2,721	78.5	38.7	-1.4
Electrical and other machinery	1,547	3,886	6,803	1,140	151.2	75.1	-83.2
Motor vehicles and equipment, other transportation equipment	1,770	13,368	33,363	28,023	655.3	149.6	-16.0
Other and miscellaneous	8,223	12,828	13,688	30,839	56.0	6.7	125.3
Other Commodity Producing	24,220	36,868	38,155	29,397	53.1	4.5	-23.0
Mining	12,204	10,791	11,238	7,376	-11.6	4.1	-34.4
Contract construction	12,016	25,776	22,553	22,021	114.5	-12.5	-2.4
Armed forces	0	301	4,364	1/		1349.8	
Distributive	75,481	102,441	108,260	112,183	35.7	5.7	3.6
Railroads and railway express	11,019	13,749	8,795	5,334	24.8	-36.0	-39.4
Trucking and warehousing	3,476	4,290	6,029	5,584	23.4	40.5	-7.4
Other transportation	2,261	3,102	3,191	3,270	37.2	2.9	2.5
Communications	2,796	4,562	4,832	4,250	63.2	5.9	-12.0
Utilities and sanitary service	3,700	6,154	7,307	7,389	66.3	18.7	1.1
Wholesale trade	9,714	12,661	13,337	15,807	30.3	5.3	18.5
Food and dairy product stores	9,409	9,998	10,274	10,184	6.3	2.8	-0.9
Eating and drinking places	6,839	10,622	11,837	13,265	55.3	11.4	12.1
Other retail trade	26,267	37,303	42,658	47,100	42.0	14.4	10.4
Service	70,074	81,361	111,606	132,403	16.1	37.2	18.6
Finance, insurance and real estate	7,871	9,757	13,328	15,948	24.0	36.6	19.7
Hotels and other personal service	10,729	10,904	11,625	12,301	1.6	6.6	5.8
Private households	10,572	7,256	9,741	6,348	-31,4	34.3	-34.8
Business and repair services	6,640	8,807	8,555	10,427	32.6	-2.9	21.9
Entertainment, recreation services	2,356	3,025	2,519	3,040	28.4	-16.7	20.7
Medical, other professional service	23,393	29,593	50,046	34,224	26.5	69.1	-31.6
Public administration	8,513	12,019	15,792	50,115	41.2	31.4	217.3
Industry not reported	3,912	6,748	11,301	6,564	72.5	67.5	-41.9
Total	284,424	350,097	393,509	397,210	23.1	12.4	0.9

Source: Growth Patterns in Employment by County, 1940-1950, and 1950-1960, Vol. 4, Plains, Office of Business Economics, U. S. Department of Commerce 1965

1/ Not delineated in the 1970 U. S. Census

Arkansas River Basin-Kansas
Exhibit 55 - Employment: Historical and Projected by Industrial Groupings for the State of Kansas

Industrial Group	Historical				Projected		
	1940	1950	1960	1970	1980	2000	2020
Agricultural	186,251	165,940	107,726	74,794	81,000*	63,200*	48,100*
Manufacturing	53,862	90,594	134,064	147,933	180,600*	225,100*	280,300*
Other Commodity Producing	44,532	79,963	99,636	61,651	126,800	154,300	196,700
Distributive	153,412	209,385	230,517	250,751	306,000	396,800	490,400
Service	145,769	175,126	245,645	317,184	379,800	545,400	747,400
Total	583,826	721,008	817,588	852,313	1,074,200*	1,384,800*	1,762,900*

* Series "C" projections for Kansas from the Office of Business Economics

Source: Developed from OBE data, and adjusted for series "C" projections for state of Kansas

Arkansas River Basin-Kansas
Exhibit 56 - Employment: Historical and Projected
by Industrial Groupings
Study Areas

Industrial group and area	Historical				Projected		
	1940	1950	1960	1970	1980	2000	2020
Agricultural							
Study area	87,313	76,770	50,227	36,278	37,200	28,600	21,600
Upper Arkansas	11,565	12,220	9,273	7,612	8,500	7,000	5,200
Cimarron	3,924	4,456	3,360	3,283	3,200	2,700	2,000
Lower Arkansas	30,627	26,418	17,567	12,236	13,700	9,800	7,100
Walnut-Verdigris	16,375	12,812	7,326	4,979	4,100	3,200	2,600
Neosho	24,822	20,864	12,701	8,168	7,700	5,900	4,700
Manufacturing							
Study area	24,961	48,385	77,631	80,385	102,600	128,400	162,800
Upper Arkansas	808	1,251	1,693	2,636	2,000	2,500	2,900
Cimarron	226	551	798	1,299	1,000	1,200	1,400
Lower Arkansas	13,417	30,515	53,745	51,294	70,800	87,900	111,000
Walnut-Verdigris	6,514	9,021	11,791	12,256	15,500	19,900	25,600
Neosho	3,996	7,047	9,604	12,900	13,300	16,900	21,900
Other Commodity Producing							
Study area	24,549	37,582	39,284	29,397	50,000	60,800	77,500
Upper Arkansas	978	3,125	2,814	2,405	3,900	4,600	5,800
Cimarron	443	1,923	2,632	2,006	3,400	4,000	4,900
Lower Arkansas	11,450	19,514	21,916	15,611	27,300	33,600	42,600
Walnut-Verdigris	5,009	6,341	6,225	4,424	8,000	9,700	12,600
Neosho	6,669	6,679	5,697	4,951	7,400	8,900	11,600
Distributive							
Study area	76,537	104,429	111,457	112,183	147,500	189,600	233,500
Upper Arkansas	5,853	9,138	9,493	10,174	12,700	16,300	20,000
Cimarron	1,862	3,788	5,256	5,400	7,000	9,000	11,000
Lower Arkansas	37,615	53,949	60,707	63,495	80,300	103,200	127,100
Walnut-Verdigris	12,819	15,493	15,928	14,146	21,000	27,000	33,400
Neosho	18,388	22,061	20,073	18,968	26,500	34,100	42,000
Service							
Study area	71,064	82,931	114,910	132,403	173,700	247,600	333,600
Upper Arkansas	6,322	7,470	10,325	11,754	16,700	23,900	32,100
Cimarron	2,066	2,557	4,115	4,791	6,400	9,000	12,100
Lower Arkansas	35,320	44,416	65,456	76,895	100,100	142,700	192,400
Walnut-Verdigris	12,126	12,322	15,145	16,366	21,900	31,100	41,900
Neosho	15,230	16,166	19,869	22,597	28,600	40,900	55,100
Total Employment							
Study area	284,424	350,097	393,509	397,210 1/	511,000	655,000	829,000
Upper Arkansas	25,526	33,204	33,598	35,120	43,800	54,300	66,000
Cimarron	8,521	13,275	16,161	17,099	21,000	25,900	31,400
Lower Arkansas	128,429	174,812	219,391	223,332	292,200	377,200	480,200
Walnut-Verdigris	52,843	55,989	56,415	52,959	70,500	90,900	116,100
Neosho	69,105	72,817	67,944	68,700	83,500	106,700	135,300

1/ Includes Industry Not Reported: Study Area = 6,564; Upper Arkansas = 539; Cimarron = 320; Lower Arkansas = 3801; Walnut-Verdigris = 788; Neosho = 1,116

Source: Developed from OBE data and adjusted for Series "C" projection for the State of Kansas

Arkansas River Basin-Kansas
Exhibit 57 - Historic and Projected Population

Area	Historical				Projected		
	1940	1950	1960	1970 1/	1980	2000	2020
Kansas	1,801,028	1,905,299	2,178,611	2,249,071	2,768,600 2/	3,514,700 2/	4,407,400 2/
Arkansas Basin	885,624	942,291	1,059,330	1,040,340	1,316,900	1,662,300	2,072,400
Upper Arkansas	83,067	93,063	90,920	90,885	112,900	137,800	165,000
Cimarron	26,999	36,261	42,952	43,246	54,100	65,700	78,500
Lower Arkansas	375,227	449,617	579,711	576,571	753,000	957,300	1,200,500
Walnut-Verdigris	171,512	156,837	156,597	142,577	181,700	230,700	290,200
Neosho	228,819	206,513	189,150	187,061	215,200	270,800	338,200

1/ Preliminary.

2/ Series "C" projections for Kansas from the Office of Business Economics.

Source: U.S. Census of Population
Projections were developed from OBE employment and population projections for the State of Kansas.

Arkansas River Basin-Kansas
Exhibit 58 - Land in Farms by Major Land Use Categories
1949, 1954, 1959, 1964, and 1969

Areas and Land Use	1949	1954	1959	1964	1969
	Acres	Acres	Acres	Acres	Acres
Arkansas River Basin					
Land in farms (total)	25,891,260	27,110,596	27,230,974	27,260,349	26,725,769
Cropland total	15,972,607	16,371,126	16,352,022	16,355,103	17,292,626
Harvested	11,828,420	11,711,156	11,361,261	9,976,048	9,842,892
Pastured	763,427	687,516	696,831	724,262	1,847,441
Not harvested or pastured	3,380,760	3,972,454	4,293,930	5,654,793	5,602,293
Woodland	486,027	357,083	271,500	292,474	297,403
Grassland	8,627,074	9,644,235	9,776,944	9,944,681	8,494,340
Other land	805,552	738,152	830,508	668,091	641,400
Upper Arkansas					
Land in farms (total)	6,903,272	7,542,767	7,575,879	7,578,032	7,571,733
Cropland total	4,911,077	5,277,398	5,382,380	5,326,631	5,608,250
Harvested	3,180,446	3,302,515	3,155,864	2,548,123	2,736,931
Pastured	189,012	126,687	135,258	161,627	321,699
Not harvested or pastured	1,541,619	1,848,196	2,091,258	2,616,881	2,549,620
Woodland	50,369	20,281	9,495	8,677	11,909
Grassland	1,833,736	2,135,501	2,055,549	2,143,863	1,861,444
Other land	108,090	109,587	128,455	98,861	90,130
Cimarron					
Land in farms (total)	3,315,436	3,688,278	3,618,249	3,700,199	3,754,332
Cropland total	2,376,250	2,503,185	2,438,989	2,447,898	2,541,787
Harvested	1,592,551	1,450,391	1,438,450	1,124,445	1,353,222
Pastured	52,363	94,565	74,466	73,001	130,043
Not harvested or pastured	731,336	958,229	926,073	1,250,452	1,058,522
Woodland	23,730	3,502	2,452	940	5,540
Grassland	865,975	1,136,713	1,121,525	1,208,052	1,163,235
Other land	49,481	44,878	55,283	43,309	43,770
Lower Arkansas					
Land in farms (total)	7,615,472	7,718,187	7,812,224	7,774,275	7,769,913
Cropland total	5,185,486	5,181,842	5,220,728	5,181,337	5,498,112
Harvested	4,247,611	4,155,107	4,034,498	3,648,122	3,502,374
Pastured	212,611	203,705	239,817	210,540	575,584
Not harvested or pastured	725,264	823,030	946,413	1,322,675	1,420,154
Woodland	81,297	58,026	43,501	41,183	58,759
Grassland	2,086,998	2,230,688	2,268,830	2,334,055	1,994,342
Other land	261,691	247,631	279,165	217,700	218,700
Walnut-Verdigris					
Land in farms (total)	3,717,395	3,682,078	3,741,257	3,752,125	3,465,322
Cropland total	1,319,532	1,236,907	1,219,930	1,251,182	1,323,983
Harvested	1,016,064	1,002,714	969,728	928,913	787,400
Pastured	122,379	101,018	110,602	147,054	330,195
Not harvested or pastured	181,089	133,175	139,600	175,215	206,388
Woodland	177,944	141,196	101,387	120,420	108,058
Grassland	2,051,465	2,166,473	2,261,695	2,249,139	1,906,881
Other land	168,454	137,502	158,245	131,384	126,400
Neosho					
Land in farms (total)	4,339,685	4,479,286	4,483,365	4,455,718	4,164,469
Cropland total	2,180,262	2,171,794	2,089,995	2,148,055	2,320,494
Harvested	1,791,748	1,800,429	1,762,721	1,726,445	1,462,965
Pastured	187,062	161,541	136,688	132,040	489,920
Not harvested or pastured	201,452	209,824	190,586	289,570	367,609
Woodland	152,687	134,078	114,665	121,254	113,137
Grassland	1,788,900	1,974,860	2,069,345	2,009,572	1,568,438
Other land	217,836	198,554	209,360	176,837	162,400

Source: United States Census of Agriculture.

Arkansas River Basin-Kansas

Exhibit 59 - Cropland Use by Major Crops Harvested

1949, 1954, 1959, 1964, and 1969

Area and Crop[1]	Acres Harvested				
	1949	1954	1959	1964	1969
Arkansas River Basin					
Wheat	8,007,622	5,659,866	5,952,099	5,369,789	5,670,267
Sorghum	1,445,780	3,445,878	2,898,055	2,238,697	2,144,880
Hay[2]	770,874	947,783	702,655	972,552	929,753
Corn	615,456	426,064	496,681	445,277	492,954
Soybeans	144,584	141,319	259,159	344,702	436,036
Other Small Grains	456,953	798,601	847,834	421,504	224,207
Total	11,441,269	11,419,511	11,156,483	9,792,521	9,898,097
All cropland harvested	11,828,420	11,711,156	11,361,261	9,976,048	9,995,832
Percent of cropland harvested	96.7	97.5	98.2	98.2	99.0
Upper Arkansas					
Wheat	2,610,743	1,711,173	1,994,258	1,710,631	1,888,047
Sorghum	428,150	1,399,048	952,860	644,350	528,164
Hay[2]	42,943	77,182	50,498	66,463	133,811
Corn	5,484	11,052	16,868	49,448	157,016
Soybeans	46	112	818	705	3,321
Other Small Grains	70,645	57,061	95,639	27,705	26,861
Total	3,158,011	3,255,628	3,110,941	2,499,302	2,737,220
All cropland harvested	3,180,446	3,302,515	3,155,864	2,548,123	2,765,170
Percent of cropland harvested	99.2	98.6	98.6	98.1	99.0
Cimarron					
Wheat	1,206,362	636,167	835,262	642,979	686,757
Sorghum	369,012	776,182	538,858	420,535	501,515
Hay[2]	12,079	14,405	13,078	14,019	40,979
Corn	517	1,069	10,435	26,386	113,959
Soybeans	0	0	265	748	2,506
Other Small Grains	7,257	8,803	21,103	6,975	10,610
Total	1,595,227	1,436,626	1,419,001	1,111,642	1,356,326
All cropland harvested	1,592,551	1,450,391	1,438,450	1,124,445	1,371,672
Percent of cropland harvested	100.0	99.1	98.6	98.9	98.9
Lower Arkansas					
Wheat	3,243,937	2,564,521	2,375,802	2,260,523	2,438,837
Sorghum	364,335	832,405	947,912	761,390	652,846
Hay[2]	220,249	286,913	183,009	265,057	252,134
Corn	88,962	59,363	68,464	46,273	40,869
Soybeans	2,662	11,147	19,555	48,332	45,706
Other Small Grains	134,577	297,179	361,739	223,043	95,904
Total	4,054,722	4,051,528	3,956,481	3,604,618	3,526,296
All cropland harvested	4,247,611	4,155,107	4,034,498	3,648,122	3,554,837
Percent of cropland harvested	95.4	97.5	98.1	98.8	99.2
Walnut-Verdigris					
Wheat	341,806	285,270	286,201	294,822	283,248
Sorghum	128,234	163,367	181,566	160,198	160,647
Hay[2]	217,817	254,846	187,393	261,702	207,184
Corn	160,139	82,965	108,825	73,999	38,149
Soybeans	15,708	15,691	30,373	48,514	64,598
Other Small Grains	92,367	169,634	147,663	61,853	40,298
Total	956,071	971,773	942,021	901,088	794,124
All cropland harvested	1,016,064	1,002,714	969,728	928,913	799,637
Percent of cropland harvested	94.1	96.9	97.1	97.0	99.3
Neosho					
Wheat	604,774	462,735	460,576	460,834	373,378
Sorghum	156,049	274,876	276,859	252,224	301,708
Hay[2]	277,786	314,437	268,677	365,311	295,645
Corn	360,354	271,615	292,089	249,171	142,961
Soybeans	126,168	114,369	208,148	246,403	319,905
Other Small Grains	152,107	265,924	221,690	101,928	50,534
Total	1,677,238	1,703,956	1,728,039	1,675,871	1,484,131
All cropland harvested	1,791,748	1,800,429	1,762,721	1,726,445	1,505,516
Percent of cropland harvested	93.6	94.6	98.0	97.0	98.6

1/ Ranked in order of 1964 Arkansas River Basin study area acreage.

2/ Includes alfalfa mixture.

Source: United States Census of Agriculture

Arkansas River Basin-Kansas
Exhibit 60 - Major Classes of Livestock on Farms
1949, 1954, 1959, 1964, and 1969

Area and class of livestock	Number on farms				
	1949	1954	1959	1964	1969
Arkansas River Basin					
Cattle and calves	1,745,592	2,098,628	2,231,051	2,682,135	3,188,380
Cows incl. heifers	664,298	867,894	690,103	885,316	884,160
Hogs and pigs	440,540	273,487	478,045	454,662	657,242
Sheep and lambs	285,738	306,085	465,742	368,581	319,108
Ewes	156,860	157,201	235,773	188,007	NA
Upper Arkansas					
Cattle and calves	304,881	418,368	479,608	562,883	806,045
Cows incl. heifers	110,889	153,772	107,752	137,832	130,480
Hogs and pigs	30,936	20,456	40,717	39,458	62,212
Sheep and lambs	47,444	75,368	119,172	66,266	45,620
Ewes	27,434	28,180	41,314	22,555	NA
Cimarron					
Cattle and calves	107,911	149,954	179,285	196,733	326,012
Cows incl. heifers	41,203	54,875	39,122	52,281	61,502
Hogs and pigs	8,863	4,620	11,511	11,243	24,026
Sheep and lambs	7,245	17,586	33,172	14,458	9,553
Ewes	3,946	10,828	6,964	6,415	NA
Lower Arkansas					
Cattle and calves	529,151	606,076	643,704	777,075	865,119
Cows incl. heifers	213,451	269,735	216,445	277,003	270,884
Hogs and pigs	120,053	86,123	142,351	144,198	222,554
Sheep and lambs	106,193	134,532	206,495	219,414	210,195
Ewes	53,934	65,516	117,573	116,181	NA
Walnut-Verdigris					
Cattle and calves	363,568	403,738	407,335	500,159	529,378
Cows incl. heifers	137,306	183,197	157,668	210,367	208,734
Hogs and pigs	114,624	61,099	109,492	105,145	148,822
Sheep and lambs	36,535	29,080	39,220	28,112	23,751
Ewes	19,318	19,915	25,955	17,607	NA
Neosho					
Cattle and calves	440,081	520,492	521,119	645,285	661,826
Cows incl. heifers	161,449	206,315	169,116	207,833	212,560
Hogs and pigs	166,064	101,189	173,974	154,618	199,628
Sheep and lambs	88,321	49,519	67,683	40,331	29,989
Ewes	52,228	32,762	43,967	25,249	NA

Source: United States Census of Agriculture

Arkansas River Basin-Kansas
Exhibit 61 - Cash Receipts from Farm Marketing
1949, 1954, 1959, 1964, and 1969

Source and area	1949	1954	1959	1964	1969
	Dollars	Dollars	Dollars	Dollars	Dollars
All Farm Products Sold					
Arkansas River Basin	406,442,167	416,643,636	608,646,913	647,116,083	1,069,948,009
Upper Arkansas	90,260,670	86,215,645	151,928,191	161,825,713	328,589,948
Cimarron	50,221,003	33,715,308	64,590,118	61,040,814	130,474,516
Lower Arkansas	131,460,139	159,893,136	192,392,091	211,380,482	301,511,935
Walnut-Verdigris	56,223,017	53,009,572	75,754,304	72,447,681	124,517,524
Neosho	78,277,338	83,809,975	123,982,209	140,421,393	184,854,086
All Crops Sold					
Arkansas River Basin	194,947,393	228,079,206	273,891,684	245,123,125	321,207,082
Upper Arkansas	57,079,078	55,669,196	76,766,867	57,327,357	94,466,819
Cimarron	35,660,498	21,101,780	38,734,835	29,917,916	55,889,209
Lower Arkansas	65,915,509	103,024,806	100,303,094	94,258,341	109,255,755
Walnut-Verdigris	13,415,746	19,047,770	20,471,699	20,941,884	19,990,902
Neosho	22,876,562	29,235,654	37,615,189	42,677,627	41,604,397
Livestock and Livestock Products Sold					
Arkansas River Basin	211,494,774	188,564,430	334,755,229	401,992,958	748,740,927
Upper Arkansas	33,181,592	30,546,449	75,161,324	104,498,356	234,123,129
Cimarron	14,560,505	12,613,528	25,855,283	31,122,898	74,585,307
Lower Arkansas	65,544,630	56,868,330	92,088,997	117,122,141	192,256,180
Walnut-Verdigris	42,807,271	33,961,802	55,282,605	51,505,797	104,526,622
Neosho	55,400,776	54,574,321	86,367,020	97,743,766	143,249,689

Source: United States Census of Agriculture

Arkansas River Basin-Kansas
Exhibit 62 - Number and Size of Farms
1949, 1954, 1959, 1964, and 1969

Year	Farms		Size of Farms	
	Number	Pct. 1949	Acres	Pct. 1949
Arkansas River Basin				
1949	62,540	100	414	100
1954	57,637	92	470	114
1959	50,294	80	541	131
1964	44,976	72	606	146
1969	42,068	67	636	154
Upper Arkansas				
1949	8,675	100	796	100
1954	8,736	101	863	108
1959	8,187	94	925	116
1964	7,345	85	1,032	130
1969	7,641	88	991	125
Cimarron				
1949	3,052	100	1,086	100
1954	3,139	103	1,175	108
1959	2,750	90	1,316	121
1964	2,527	83	1,464	135
1969	2,798	92	1,341	124
Lower Arkansas				
1949	20,920	100	364	100
1954	19,319	92	400	110
1959	17,090	82	457	126
1964	15,351	74	506	139
1969	14,469	69	537	148
Walnut-Verdigris				
1949	11,538	100	322	100
1954	10,082	87	365	113
1959	8,499	74	440	137
1964	7,594	66	494	153
1969	6,701	58	517	160
Neosho				
1949	18,355	100	236	100
1954	16,361	89	274	116
1959	13,768	75	326	138
1964	12,159	66	366	155
1969	10,449	57	399	169

Source: United States Census of Agriculture

Arkansas River Basin-Kansas
Exhibit 63 - Value of Land and Buildings
1950, 1954, 1959, 1964, and 1969

Area, Value Per Farm and Per Acre	Value of Land and Buildings in Dollars				
	1950	1954	1959	1964	1969
Arkansas River Basin					
Per Farm	31,301	42,462	59,694	79,528	103,217
Per Acre	68	83	105	128	162
Upper Arkansas					
Per Farm	53,572	65,335	84,515	118,941	137,478
Per Acre	66	75	91	114	139
Cimarron					
Per Farm	64,835	81,174	115,269	151,151	182,587
Per Acre	60	66	93	113	136
Lower Arkansas					
Per Farm	34,555	47,549	63,720	79,424	106,591
Per Acre	95	114	135	160	198
Walnut-Verdigris					
Per Farm	18,536	28,092	42,497	56,881	80,612
Per Acre	54	73	94	113	156
Neosho					
Per Farm	15,526	21,442	32,556	45,886	66,411
Per Acre	44	64	98	122	166

Source: United States Census of Agriculture

Arkansas River Basin-Kansas
Exhibit 64 - Farms Reporting Irrigation and Acres Irrigated
1949, 1954, 1959, 1964, and 1969

Item	1949	1954	1959	1964	1969
Arkansas River Basin					
No. of Farms	1,014	2,026	2,963	3,137	3,851
Acres	132,582	289,650	629,114	803,053	1,174,781
Upper Arkansas					
No. of Farms	797	1,301	1,646	1,658	1,964
Acres	106,881	190,308	351,845	409,858	566,223
Cimarron					
No. of Farms	120	293	562	718	1,015
Acres	23,207	76,639	229,886	336,770	519,674
Lower Arkansas					
No. of Farms	85	335	679	657	769
Acres	2,405	19,063	44,823	50,778	83,440
Walnut-Verdigris					
No. of Farms	7	43	32	49	48
Acres	61	2,009	1,100	2,996	3,729
Neosho					
No. of Farms	5	54	44	55	55
Acres	28	1,631	1,460	2,651	1,715

Source: United States Census of Agriculture

Arkansas River Basin-Kansas
Exhibit 65 - Current Normal Production and
Projected Agricultural Requirements for the State of Kansas

Commodity	Unit	Current Normal Production 1/	Projected Requirements		
			1980	2000	2020
		- - - - - - - - Million Units - - - - - - -			
Wheat	Bu.	202.4	323.4	367.2	424.4
Corn, grain	Bu.	64.0	77.8	89.2	98.1
Sorghum, grain	Bu.	153.2	254.3	373.8	539.2
Oats	Bu.	12.9	13.4	11.9	8.3
Barley	Bu.	18.4	22.6	22.4	20.2
Soybeans	Bu.	16.0	23.5	29.6	38.1
		- - - - - - - Thousand Units - - - - - - -			
Sugarbeets	Ton	208	426	897	1,673
Roughages					
Corn, silage	Ton	3,555	5,540	6,790	9,056
Sorghum, silage 2/	Ton	9,973	15,546	19,049	25,401
Alfalfa hay 3/	Ton	2,854	4,445	5,451	7,269

1/ Current normal values reflect current production technology and prices from which the impacts of abnormalities caused by weather and other hazards in a single year were weighted by their historical occurrence. These values are based on historical data for the years 1939 to 1963 adjusted by a process which progressively weighted each successive year in the historical series.

2/ Includes sorghum forage converted to sorghum silage

3/ Includes alfalfa mixtures

Arkansas River Basin-Kansas

Exhibit 66 - Index of Projected Yields and Fertilizer Requirements 1/

1980, 2000, and 2020

Crop	1980				2000				2020			
	Yield	N	P	K	Yield	N	P	K	Yield	N	P	K
Dryland												
Wheat	164	314	190	200	197	428	263	300	219	528	336	400
Corn, grain	139	210	193	375	170	262	300	475	196	302	343	550
Corn, silage	146	412	394	5,800	176	509	494	8,050	195	603	547	8,750
Sorghum, grain	134	306	257	400	160	400	329	1,000	184	500	443	1,200
Sorghum, silage	149	891	800	--	169	1,200	1,080	--	184	1,445	1,340	--
Oats	137	200	94	200	167	247	125	250	192	276	138	300
Barley	139	378	175	300	165	500	212	300	184	578	262	400
Alfalfa hay	125	1,100	544	9,100	140	1,350	656	10,500	150	1,350	756	11,600
Soybeans	123	--	1,075	--	138	--	1,175	--	149	--	1,250	--
Cropland pasture	137	575	417	1,000	159	733	550	2,000	175	842	667	1,300
Irrigated												
Wheat	151	760	--	--	182	920	--	--	305	1,200	--	--
Corn, grain	147	147	194	--	190	190	250	--	223	220	287	--
Corn, silage	124	265	1,186	--	146	314	1,414	--	165	339	1,529	--
Sorghum, grain	139	199	940	--	177	255	1,180	--	207	297	1,140	--
Sorghum, silage	126	329	1,040	8,700	150	385	1,220	10,200	169	439	1,390	10,900
Alfalfa hay	127	--	446	--	151	--	562	--	176	--	723	--
Sugar beets	114	161	217	--	125	176	212	--	138	193	202	--
Cropland pasture	--	200	200	--	--	300	500	--	--	300	500	--

1/ The indicies in this table are based on current normal yields and fertilizer requirement equal to 100 (1965)

Arkansas River Basin-Kansas
Exhibit 67 - Current Normal Cropland and Grazing Land Production and Projected 1980 and 2000 Production Without Increased Irrigation[1/]

Crop	Unit	Current Normal	Projected Production	
			1980	2000
		--------1,000--------		
Dryland				
Wheat	Bu.	109,092	172,354	199,046
Corn, grain	Bu.	14,774	16,728	13,784
Corn, silage	Ton	999	1,567	1,672
Sorghum, grain	Bu.	70,507	129,092	181,339
Sorghum, silage	Ton	4,302	6,610	8,453
Oats	Bu.	5,257	5,213	5,239
Barley	Bu.	11,457	13,159	14,550
Alfalfa, hay	Ton	1,214	1,611	1,917
Soybeans	Bu.	7,984	10,921	14,101
Cropland pasture	Fu.	706,103	984,109	1,146,213
Irrigated				
Wheat	Bu.	7,778	14,646	17,462
Corn, grain	Bu.	3,033	9,218	15,842
Corn, silage	Ton	535	841	1,024
Sorghum, grain	Bu.	13,124	16,160	16,144
Sorghum, silage	Ton	644	1,153	1,025
Alfalfa, hay	Ton	158	261	353
Sugar beets	Ton	129	348	644
Cropland pasture	Fu.	111,773	155,014	178,150
Wild (native) hay	Ton	411	495	557
Pasture and range	Fu.	3,834,180	5,878,467	6,534,700
Grazed woodland	Fu.	99,015	113,458	119,169
Total				
Wheat	Bu.	116,870	187,000	216,508
Corn, grain	Bu.	17,807	25,946	29,626
Corn, silage	Ton	1,534	2,408	2,696
Sorghum, grain	Bu.	83,631	145,252	197,483
Sorghum, silage	Ton	4,946	7,763	9,478
Oats	Bu.	5,257	5,213	5,239
Barley	Bu.	11,457	13,159	14,550
Alfalfa hay	Ton	1,372	1,872	2,270
Soybeans	Bu.	7,984	10,921	14,101
Sugar beets	Ton	129	348	644
Wild (native) hay	Ton	411	495	557
Cropland pasture	Fu.	817,876	1,139,123	1,324,363
Pasture and range	Fu.	3,834,180	5,878,467	6,534,700
Grazed woodland	Fu.	99,015	113,458	119,169

1/ Study area projected production with current normal state level of irrigation.

Arkansas River Basin-Kansas
Exhibit 68 - Current Normal Cropland and
Grazing Land Production
and Projected 1980 and 2000 Production
With Increased Irrigation[1/]

Crop	Unit	Current Normal	Projected Production	
			1980	2000
		-------------------	1,000	-------------------
Dryland				
Wheat	Bu.	109,092	134,393	142,117
Corn, grain	Bu.	14,774	12,590	15,282
Corn, silage	Ton	999	1,360	1,521
Sorghum, grain	Bu.	70,507	94,072	93,580
Sorghum, silage	Ton	4,302	6,713	5,650
Oats	Bu.	5,257	6,754	4,787
Barley	Bu.	11,457	14,048	13,527
Alfalfa, hay	Ton	1,214	1,385	1,463
Soybeans	Bu.	7,984	11,267	14,372
Cropland pasture	Fu.	706,103	984,109	1,080,902
Irrigated				
Wheat	Bu.	7,778	41,485	55,992
Corn, grain	Bu.	3,033	21,420	15,461
Corn, silage	Ton	535	1,676	1,167
Sorghum, grain	Bu.	13,124	66,833	155,932
Sorghum, silage	Ton	644	1,086	5,040
Alfalfa, hay	Ton	158	338	920
Sugar beets	Ton	129	348	765
Cropland pasture	Fu.	111,773	155,014	265,903
Wild (native) hay	Ton	411	493	557
Pasture and range	Fu.	3,834,180	5,878,468	6,534,703
Grazed woodland	Fu.	99,015	113,457	119,169
Total				
Wheat	Bu.	116,870	175,878	198,109
Corn, grain	Bu.	17,807	34,010	30,743
Corn, silage	Ton	1,534	3,036	2,688
Sorghum, grain	Bu.	83,631	160,905	249,512
Sorghum, silage	Ton	4,946	7,799	10,690
Oats	Bu.	5,257	6,754	4,787
Barley	Bu.	11,457	14,048	13,527
Alfalfa hay	Ton	1,372	1,723	2,383
Soybeans	Bu.	7,984	11,267	14,372
Sugar beets	Ton	129	348	765
Wild (native) hay	Ton	411	493	557
Cropland pasture	Fu.	817,876	1,139,123	1,346,805
Pasture and range	Fu.	3,834,180	5,878,468	6,534,703
Grazed woodland	Fu.	99,015	113,457	119,169

1/ Study area production with state irrigation acreage as projected by the Kansas Water Resources Board.

Arkansas River Basin-Kansas
Exhibit 69 - 1965 and Projected Total Irrigated
Acreages by Planning Units

Units	1965	1980	2000
Upper Arkansas	490,900	1,004,000	1,549,000
Cimarron	398,100	742,200	1,041,000
Lower Arkansas	54,000	209,300	697,600
Walnut-Verdigris	3,210	12,300	25,200
Neosho	2,280	7,420	16,100
Total	948,490	1,975,220	3,328,900

Source: Kansas Water Resources Board

Arkansas River Basin-Kansas
Exhibit 70 - Current Normal Use of Agricultural Land and Projected 1980 and 2000 Use Without Increased Irrigation[1]

Crop	Current Normal	Projected Acres	
		1980	2000
Dryland			
Wheat	5,026,779	4,973,728	4,795,372
Corn, grain	311,285	243,911	168,480
Corn, silage	113,910	114,385	104,706
Sorghum, grain	2,076,118	2,785,270	3,323,668
Sorghum, silage	587,897	558,505	694,483
Oats	211,809	150,940	125,603
Barley	522,007	432,088	402,361
Alfalfa, hay	597,074	636,005	659,206
Soybeans	396,393	395,702	453,498
Cropland pasture	443,586	441,580	440,260
Other crops harvested	98,765	98,263	97,875
Summer fallow	2,265,969	2,429,370	2,268,115
Idle cropland	2,076,501	1,406,193	1,084,032
Non-irrigated total	14,728,093	14,665,940	14,617,659
Irrigated			
Wheat	198,698	246,224	243,000
Corn, grain	37,962	78,076	104,010
Corn, silage	34,624	43,036	43,845
Sorghum, grain	157,598	141,849	111,463
Sorghum, silage	36,513	51,846	38,295
Alfalfa, hay	37,931	49,792	56,519
Sugar beets	7,609	18,029	30,284
Cropland pasture	26,777	26,697	26,643
Other crops harvested	31,850	31,751	31,681
Idle cropland	141,199	21,324	21,329
Irrigated cropland total	710,761	708,624	707,069
Cropland total	15,438,854	15,374,564	15,324,728
Wild (native) hay	363,859	361,729	360,547
Pasture and range	9,021,853	8,980,190	8,952,363
Pasture and range total	9,385,712	9,341,919	9,312,910
Grazed woodland	356,629	354,533	353,436
Non-grazed woodland	246,962	245,659	244,760
Woodland total	603,591	600,192	598,196
Other agricultural land	230,064	228,880	227,997
Total land	25,658,221	25,545,555	25,463,831

1/ Study area acres required to meet 1980 and 2000 projected state requirements.

Arkansas River Basin-Kansas

Exhibit 71 - Current Normal Use of Agricultural Land and Projected 1980 and 2000 Use With Increased Irrigation[1/]

Crop	Current Normal	Projected Acres	
		1980	2000
Dryland			
Wheat	5,026,779	3,875,566	3,371,661
Corn, grain	311,285	186,772	185,394
Corn, silage	113,910	102,519	101,138
Sorghum, grain	2,076,118	2,044,440	1,680,480
Sorghum, silage	587,897	622,394	447,926
Oats	211,809	190,174	112,086
Barley	522,007	465,217	385,121
Alfalfa, hay	597,074	545,917	514,890
Soybeans	396,393	407,475	455,281
Cropland pasture	443,586	441,580	413,250
Other crops harvested	98,765	98,263	92,697
Summer fallow	2,265,969	1,610,524	1,223,003
Idle cropland	2,076,501	2,980,384	3,239,662
Non-irrigated total	14,728,093	13,571,225	12,222,589
Irrigated			
Wheat	198,698	681,636	678,648
Corn, grain	37,962	180,847	101,503
Corn, silage	34,624	85,699	50,268
Sorghum, grain	157,598	573,349	1,031,201
Sorghum, silage	36,513	48,779	174,452
Alfalfa, hay	37,931	61,694	141,466
Sugar beets	7,609	18,029	35,933
Cropland pasture	26,777	26,697	39,775
Other crops harvested	31,850	31,751	49,757
Idle cropland	141,199	92,875	798,958
Irrigated cropland total[2/]	710,761	1,801,356	3,101,961
Cropland total	15,438,854	15,372,581	15,324,550
Wild (native) hay	363,859	361,729	360,547
Pasture and range	9,021,853	8,980,190	8,952,363
Pasture and range total	9,385,712	9,341,919	9,312,910
Grazed woodland	356,629	354,533	353,436
Non-grazed woodland	246,962	245,659	244,760
Woodland total	603,591	600,192	598,196
Other agricultural land	230,064	228,880	227,997
Total land	25,658,221	25,543,572	25,463,653

1/ Study area acres required to meet projected requirements with state irrigated acreage as projected by the Kansas Water Resources Board.

2/ Deduction made for non-agricultural use of land.

Arkansas River Basin-Kansas
Exhibit 72 - Value of Current Normal and
Projected 1980 and 2000 Production
Without Increased Irrigation

Crop	Unit	$/Unit	Value of Production		
			Current Normal	1980	2000
			$(000)	$(000)	$(000)
Wheat	Bu.	1.31	153,100	244,970	283,625
Corn, grain	Bu.	1.01	17,985	26,205	29,922
Corn, silage	Ton	8.00	12,272	19,264	21,568
Sorghum, grain	Bu.	.89	74,432	129,274	175,760
Sorghum, silage	Ton	7.00	34,622	54,341	66,346
Oats	Bu.	.63	3,312	3,284	3,300
Barley	Bu.	.74	8,478	9,738	10,767
Alfalfa	Ton	20.02	27,467	37,477	45,445
Soybeans	Bu.	2.30	18,363	25,118	32,432
Sugar beets	Ton	11.12	1,434	3,870	7,161
Wild (native) hay	Ton	20.02	8,228	9,910	11,151
Subtotal			359,693	563,451	687,477
Cropland pasture	Fu.	.0168	13,740	19,137	22,249
Pasture and range	Fu.	.0168	64,414	98,758	109,783
Grazed woodland	Fu.	.0168	1,663	1,906	2,002
Subtotal			79,817	119,801	134,034
Total			439,510	683,252	821,511

Arkansas River Basin-Kansas

Exhibit 73 - Value of Projected 1980 and 2000 Production With Increased Irrigation and Potential 1980 Production[1/]

Crop	Unit	$/Unit	Value of Production		
			1980	1980 Potential	2000
			$(000)	$(000)	$(000)
Wheat	Bu.	1.31	230,400	234,041	259,523
Corn, grain	Bu.	1.01	34,350	19,812	31,050
Corn, silage	Ton	8.00	24,288	21,552	21,504
Sorghum, grain	Bu.	.89	143,205	253,551	222,066
Sorghum, silage	Ton	7.00	54,593	53,648	74,830
Oats	Bu.	.63	4,254	2,885	3,016
Barley	Bu.	.74	10,396	10,158	10,010
Alfalfa	Ton	20.02	34,494	39,920	47,708
Soybeans	Bu.	2.30	25,914	25,206	33,056
Sugar beets	Ton	11.12	3,870	3,870	8,507
Wild (native) hay	Ton	20.02	9,870	9,870	11,151
Subtotal			575,634	674,513	722,421
Cropland pasture	Fu.	.0168	19,137	19,137	22,249
Pasture and range	Fu.	.0168	98,758	98,758	109,783
Grazed woodland	Fu.	.0168	1,906	1,906	2,002
Subtotal			119,801	119,801	134,034
Total			695,435	794,314	856,455

1/ Study area production with irrigated acreage for the state as projected by Kansas Water Resources Board. The value of 1980 potential production is based on maximum use of study area idle land for grain sorghum production.

Arkansas River Basin-Kansas
Exhibit 74 - Schedule of Federal Funding to Complete
Early Action Watershed Project Installation
by 1990